

Atlas of Agriculture in the Lao PDR

Patterns and trends between
1999 and

2011





Lao DECIDE info
w w w . d e c i d e . l a
Informing Decisions for Sustainable Development

Atlas of Agriculture in the Lao PDR

Patterns and trends between 1999 and 2011



u^b

u^b
UNIVERSITÄT
BERN

CDE
CENTRE FOR DEVELOPMENT
AND ENVIRONMENT

Centre for Development and Environment (CDE), University of Bern, Switzerland, and
Ministry of Agriculture and Forestry (MAF), Lao PDR, with Bern Open Publishing (BOP), 2018

Developed and edited by:

Michael Epprecht, Anne-Kathrin Weber, Rasso Bernhard, Khamlouang Keoka, Thatheva Saphangthong, Vongpaphane Manivong, Phanxay Ingxay, Phanthavong Vongsamphanh, Nicholas Bosoni, Savanh Hanephom, Phonesavan Vanmeexai, Aengsone Kaungbounhieng, Hairkham Sisouvan, Sengphachan Khounthikoumman, Porha Xaichounorxoa, Micah Ingalls, Vong Nanhthavong, Juliet Lu, Inthaneth Norasingh, Urs Wiesmann, Thomas Breu

Funded by the Swiss Agency for Development and Cooperation SDC



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

**Swiss Agency for Development
and Cooperation SDC**

Disclaimer:

The boundaries, colours, denominations, and any other information shown on the maps of this atlas do not imply any judgement on the legal status of any territory, or any official endorsement or acceptance of the boundaries on the part of the government of the Lao PDR.

© 2018 Centre for Development and Environment (CDE), University of Bern, Switzerland, and Ministry of Agriculture and Forestry (MAF), Lao PDR, with Bern Open Publishing (BOP).

This atlas is licensed under a Creative Commons Attribution 4.0 International (CC BY 4.0) License (<http://creativecommons.org/licenses/by/4.0/>). Anyone may read, download, copy, reuse, distribute, print, search, and link to the contents of this atlas provided that the original authors and source are properly acknowledged and cited, including both publishing organizations, CDE and MAF. For any reuse or redistribution of a work, the license terms under which the work was published must be made clear.

Prepared by: Centre for Development and Environment (CDE), University of Bern, Switzerland, and Ministry of Agriculture and Forestry (MAF), Lao PDR

Contributing authors and editors: Michael Epprecht, Anne-Kathrin Weber, Rasso Bernhard, Khamlouang Keoka, Thatheva Saphangthong, Vongpaphane Manivong, Phanxay Ingxay, Phanthavong Vongsamphanh, Nicholas Bosoni, Savanh Hanephom, Phonesavan Vanmeexai, Aengsone Kaungbounhieng, Hairkham Sisouvan, Sengphachan Khounthikoumman, Porha Xaichounorxoa, Micah Ingalls, Vong Nanhthavong, Juliet Lu, Inthaneth Norasingh, Urs Wiesmann, Thomas Breu

Cartography: Anne-Kathrin Weber, Rasso Bernhard, Michael Epprecht, Chantavone Phomphakdy, Hairkham Sisouvan, Sengphachan Khounthikoumman, Porha Xaichounorxoa

Layout and design: Watcharapol Isarankul Na Ayuthaya

Printed by: Pankham Jampa Printing, Vientiane, Lao PDR

Funding: Swiss Agency for Development and Cooperation (SDC)

DOI: <https://doi.org/10.7892/boris.116598>

ISBN (e-print): 978-3-906813-57-8

ISBN (print): 978-3-906813-56-1

Contacts: Centre for Development and Environment CDE, University of Bern, Switzerland; www.cde.unibe.ch; publications@cde.unibe.ch
Ministry of Agriculture and Forestry, Vientiane, Lao PDR; www.maf.gov.la; maf.info@gmail.com

Citation: Epprecht Michael, Weber Anne-Kathrin, Bernhard Rasso, Keoka Khamlouang, Saphangthong Thatheva, Manivong Vongpaphane, Ingxay Phanxay, Vongsamphanh Phanthavong, Bosoni Nicholas, Hanephom Savanh, Vanmeexai Phonesavan, Kaungbounhieng Aengsone, Sisouvan Hairkham, Khounthikoumman Sengphachan, Xaichounorxoa Porha, Ingalls Micah, Nanhthavong Vong, Lu Juliet, Norasingh Inthaneth, Wiesmann Urs, Breu Thomas. 2018. Atlas of agriculture in the Lao PDR: Patterns and trends between 1999 & 2011. Bern, Switzerland and Vientiane, Lao PDR: Centre for Development and Environment, University of Bern, and Ministry of Agriculture, Lao PDR, with Bern Open Publishing. 164 pp.

CONTENTS

LIST OF FIGURES	12
LIST OF TABLES.....	12
LIST OF ABBREVIATIONS	13
FOREWORD	14
PREFACE.....	15
ACKNOWLEDGEMENTS	17
BACKGROUND ON THE ATLAS AND THE CENSUSES.....	18
 NATIONAL CONTEXT	 21
 INTRODUCTION.....	 27
A1 PERSPECTIVE FROM SPACE	28
A2 RELIEF, CLIMATE, AND TRANSPORTATION NETWORKS	30
A3 ADMINISTRATIVE DIVISIONS	32
A4 ACCESSIBILITY OF VILLAGES.....	34
A5 ACCESSIBILITY OF MARKETS	36
A6 MAIN LAND TYPES.....	38
 AGRICULTURAL OVERVIEW.....	 41
B1 AGRICULTURAL LAND	42
B2 IRRIGATION FACILITIES	44
B3 SHIFTING AND ROTATING CULTIVATION	46
B4 AGRICULTURAL POPULATION	48
B5 AGRICULTURAL AREA AFFECTED BY UXO	50
B6 RATIO OF MARKET TO SUBSISTENCE ORIENTED HOUSEHOLDS.....	52
B7 GENDER DIMENSIONS OF WAGES AND HEADS OF HOUSEHOLDS.....	54
B8 SOURCE OF AGRICULTURAL INCOME	56
B9 NATURAL DISASTERS: FLOOD, DROUGHT AND LANDSLIDES	58
B10 CREDIT FACILITY AND SELLING AGRICULTURAL PRODUCE	60
 CROPS.....	 63
C1 RATIO OF PERENNIAL TO ANNUAL WET SEASON CROPS	64
C2 AREA AND NUMBER OF HOUSEHOLDS OF ANNUAL AND PERENNIAL CROPS	66
C3 DIVERSITY OF CROPS.....	68

RICE	
C4 UPLAND RICE IN WET SEASON	70
C5 LOWLAND RICE IN WET SEASON.....	72
C6 LOWLAND RICE IN DRY SEASON	74
C7 DEVELOPMENT OF RICE AREAS	76
C8 DEVELOPMENT OF RICE VARIETIES	80
NON-RICE ANNUAL CROPS	
C9 MAIN ANNUAL CROPS	82
C10 CROP CLUSTERS - ANNUAL CROPS.....	84
C11 MAIZE.....	86
C12 JOB'S TEARS.....	90
C13 CASSAVA	92
C14 PEANUT	96
C15 SOYBEAN.....	100
C16 SUGARCANE	104
C17 SWEET CORN.....	108
PERENNIAL CROPS	
C18 MAIN PERENNIAL CROPS.....	110
C19 CROP CLUSTERS - PERENNIAL CROPS	112
C20 RUBBER	114
C21 COFFEE.....	118
C22 BANANA.....	122
C23 CARDAMOM.....	126
C24 TEA	130
C25 MANGO.....	134
LIVESTOCK	139
D1 LIVESTOCK OVERVIEW	140
D2 VARIETY OF LIVESTOCK AND VACCINATION	142
D3 BUFFALO	144
D4 CATTLE	146
D5 PIG.....	148
D6 CHICKEN	150
D7 DUCK	152
D8 FISH CAPTURE.....	154
D9 AQUACULTURE.....	156
REFERENCES AND FURTHER READING	159

List of figures

FIGURE 1: PERCENTAGE OF AGRICULTURAL PRODUCTION PRIMARILY FOR MARKET
IN 1999 AND 2011 PER PROVINCE 52

FIGURE 2: PERCENTAGE OF AREA UNDER PERENNIAL CROPS, ANNUAL CROPS AND PASTURE LAND..... 64

FIGURE 3: DISTRIBUTION OF MAIN ANNUAL AND PERENNIAL CROP TYPES 68

FIGURE 4: TOTAL AREA OF UPLAND RICE, LOWLAND RICE IN WET SEASON
AND LOWLAND RICE IN DRY SEASON IN 2010/11 BY PROVINCE78

FIGURE 5: PROPORTION OF VILLAGES BY DOMINANT NON-RICE ANNUAL CROP IN THE VILLAGE..... 82

FIGURE 6: PROPORTION OF VILLAGES BY DOMINANT PERENNIAL CROP IN THE VILLAGE.....110

FIGURE 7: CHANGE IN LIVESTOCK POPULATIONS BETWEEN 1999 AND 2011140

List of tables

TABLE 1: TOTAL NUMBER OF HOUSEHOLDS AND AGRICULTURAL HOUSEHOLDS AND SHARE OF AGRICULTURAL
HOUSEHOLDS IN TOTAL HOUSEHOLDS IN 1999 AND 2011..... 48

TABLE 2: AREA AND PERCENTAGE OF JOB’S TEARS IN THE WET, THE DRY AND OVER BOTH
SEASONS IN 2010/11 PER PROVINCE..... 90

TABLE 3: TOTAL AND CHANGE OF AREA OF SOYBEAN BETWEEN 1999 AND 2011.....100

TABLE 4: TOTAL AREA AND PERCENTAGE OF SWEET CORN IN THE WET, THE DRY
AND BOTH SEASONS IN 2010/11108

TABLE 5: TOTAL AREA, PERCENTAGE AND CHANGE OF LAND UNDER RUBBER IN 1999 AND 2011114

TABLE 6: TOTAL AND CHANGE OF BANANA AREA BETWEEN 1999 AND 2011.....124

TABLE 7: TOTAL AND CHANGE OF MANGO AREA BETWEEN 1999 AND 2011134

List of abbreviations

ACIAR	Australian Centre for International Agricultural Research
ASEAN	Association of Southeast Asian Nations
CDE	Centre for Development and Environment, University of Bern
CIAT	International Center for Tropical Agriculture
DALaM	Department of Agricultural Land Management and Development
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FMD	Foot and Mouth Disease
GAP	Good Organic Practices
GDP	Gross Domestic Product
GI	Geographical Indicators
GIS	Geographic Information Systems
GIZ	German Corporation for International Cooperation GmbH
GoL	Government of the Lao PDR
ha	Hectare
hh	household
HS	Haemorrhagic Septicaemia
IRRI	International Rice Research Institute
JICA	Japan International Cooperation Agency
km	Kilometre
Lao PDR	Lao People's Democratic Republic
LCA	Lao Census of Agriculture
m	Metre
MAF	Ministry of Agriculture and Forestry
masl	Metre above sea level
NAFRI	National Agriculture and Forestry Research Institute
NBCA	National Biodiversity Conservation Areas
NGD	National Geographic Department of the Lao PDR
NRA	National Regulatory Authority
NSEDP	National Socioeconomic Development Plan
NTFPs	Non-Timber Forest Products
OA	Organic Agriculture
SDC	Swiss Agency for Development and Cooperation
SDG	Sustainable Development Goals
UN	United Nations
UXO	Unexploded Ordnance

Foreword

The Government of the Lao PDR has always recognized the great importance of the development of the country’s immense agricultural potential. The sector’s very significant contribution to the strong national growth, and the country’s promising path towards a smooth graduation from the status of least developed countries, is evidence of the wise guidance by the country’s leaders.

The Censuses of Agriculture, conducted first in 1999 and subsequently in 2011, constitute a landmark in information development for analysis, planning, and decision-making in the agricultural sector of the Lao PDR. Providing insights on key aspects of agricultural production of each household, the censuses are the most significant national statistical information on rural livelihood activities of the Lao population.

Using detailed geographic information, combined with the rich statistical data of the census, the variations of local characteristics of agricultural production across the country and over time is revealed for the first time in great detail.

Such new knowledge is essential not only for monitoring progress towards stated development goals such as those set out in the 8th National Socioeconomic Development Plan, but also as a vital evidence base for drawing up sustainable development pathways in the agricultural sector specifically, and for rural development in general, as outlined in key documents such as the Agriculture Development Strategy 2025.

It is my hope that this new knowledge base will be used widely as a reference among planners and decision makers within the Government to support the continued sustainable development of our great country.



Dr. Phouang Parisak Pravongviengkham
Deputy Minister of the Ministry of Agriculture and Forestry

Preface

There is general agreement that agricultural development will be crucial to successful implementation of the United Nations 2030 Agenda for Sustainable Development. The challenge for the agricultural sector lies not just in increasing productivity to feed a growing population, but in promoting agricultural development such that it supports rural development in an intact environment while contributing global environmental services. In this respect, multifunctional agriculture is a promising way forward. This concept goes beyond the provision of food, fodder, fibres, and biofuels: It addresses other agricultural functions as well, such as environmental protection, landscape preservation, employment, and public health, and it also takes into account the important role that agriculture plays in preserving local cultures and traditions.

For a long time, agricultural policies and agricultural research focused mainly on increasing productivity by means of technical innovations. Advancements were made in the fields of seeds, animal breeding, soil fertility, and irrigation, among others. This major worldwide effort - known as the Green Revolution - more than doubled global food production within 30 years. More recently, these developments have been followed by other fundamental changes in the agricultural system, including in the Lao PDR. Their main driver is the increasing globalization of agriculture and food systems. Developments like trade liberalization, foreign direct investments, and urbanization are changing agricultural structures and markets at an unprecedented speed. While increasingly globalized agriculture provides new opportunities, including economic growth, it also poses risks to people and the environment and calls for new policies and decision-making processes.

A future-oriented agriculture in an increasingly globalized world that contributes to achieving the 2030 Agenda will require knowledge and competences, financial resources, and an enabling policy environment. Governments, civil society, the private sector, and, not least, farmers' organizations will need a precise compass to guide them in their efforts. The present Atlas of Agriculture in the Lao PDR meets this need by providing comprehensive information and knowledge about key agricultural features and their dynamics.

It is my hope and my conviction that this unique atlas will serve as a powerful tool for planning, decision-making, policy formulation, and subsequent implementation on behalf of sustainable agricultural development in the Lao PDR and of global sustainable development in general.



Prof. Dr. Thomas Breu

Director of the Centre for Development and Environment CDE,
University of Bern

Acknowledgements

The development of this comprehensive atlas was made possible through the generous funding of the Lao DECIDE info initiative by the Swiss Agency for Development and Cooperation SDC, within which the atlas was developed.

Besides the dedicated contributions of a large number of individuals listed as authors in this book, over 20 individual resource persons were consulted, who provided valuable insights for the interpretation of the detected spatial patterns of agricultural production in the Lao PDR. We would like to express our sincere thanks to the following experts for their time and insights:

- Mr. Chaloun Bounithiphonh, Deputy Head of Non-timber Forestry Product Research Unit, Forestry Research Centre, NAFRI
- Dr. Bounneuang Douangboupha, Director of Horticulture Research Centre, NAFRI
- Dr. Bounthan Keoboulapha, Director of Northern Agriculture and Forestry Research Centre, NAFRI
- Mr. Southone Ketphan, Deputy Director of Forestry Research Centre, NAFRI
- Mr. Chanthasone Khamxaikhay, Deputy Director of Agriculture Land Development and Conservation Centre, Department of Agricultural Land Management and Development (DALaM)
- Dr. Sonevilay Nampanya, Project Research Officer, Australian Centre for International Agricultural Research (ACIAR), Department of Livestock and Fisheries, MAF
- Mr. Singkham Nethphunla, Director of Maize and Cash Crops Research Centre, NAFRI
- Dr. Jonathan Newby, Australian Centre for International Agricultural Research (ACIAR), CIAT
- Ms. Pamouane Phethany, Executive Director of Microfinance Association
- Dr. Siviengkhek Phommalth, Researcher of Seed Development Company, NAFRI
- Mr. Sommano Phounsavath, Director of Fisheries Division, Department of Livestock and Fisheries, MAF
- Mr. Khamphou Phouyyavong, Deputy Director of Planning and Cooperation Division, NAFRI
- Dr. Pheng Sengxua, Director of Agriculture Land Development and Conservation Centre, DALaM, MAF
- Mr. Chanphasouk Tanthaphone, Director of Policy Research Centre, NAFRI
- Dr. Isabelle Vagneron, Senior Policy Expert, CIRAD Laos
- Mr. Inpan Venesomphet, Director of Coffee Research and Multiplication Centre, NAFRI
- Dr. Khamtom Vanthanouvong, Deputy Director of Seed Development Company, NAFRI
- Mr. Somlith Vilavong, Head of Agriculture Section, Champasak Provincial Agriculture and Forestry Office, MAF
- Mr. Simone Vongkhamho, Head of NTFPs research Unit, Forestry Science Research Centre, NAFRI
- Mr. Somsamay Vongthirath, Senior Researcher on Water Resources Management/Irrigation Engineering, Agriculture and Forestry Policy Research Centre, NAFRI
- Dr. Phetmanyseng Xangsayasane, Deputy Director of Rice Research Centre, NAFRI

Background on the atlas and the censuses

This atlas of agriculture presents a comprehensive spatial analysis of the agricultural activities and production patterns in the Lao PDR in 2011, and the respective changes during the first decade of the 21st century. It presents the household-based statistics of the country's last Census of Agriculture (LCA) of 2011 at the village level, and the respective changes since the first Census of Agriculture in 1999.

The Censuses of Agriculture of 1999 and 2011 constitute important milestones in consistent statistical data collection, compilation, and analysis towards a growing national information base necessary to support well-informed planning and decision making in the agricultural sector and related sectors associated with rural development. Both census included a full enumeration of all households in the country, collecting basic demographic information, along with information on each household's agricultural activities, including number and types of livestock raised, as well as types and areas of annual and perennial crops. Additionally, much more detailed information on household activities was collected from a random sample of 5 percent of all households. In 2011, a village-level questionnaire was also administered, collecting information on aspects such as UXO and natural disaster affection, climatic and soil conditions, service infrastructure and facilities, etc. and are included in this atlas.

While the results of those censuses constitute an enormously rich source of information, both with regard to the current status of agriculture but also the trends and patterns of change in agriculture over time, the direct use and interpretation of those detailed statistics can be a big challenge. Systematic analysis of the data is therefore essential to make it useful for planning and decision making.

The nature of a census, covering by definition all households of a nation, offers a great opportunity for highly detailed geographic analysis and representation of spatial patterns and trends that are otherwise not visible in the statistical data. In order to be able to use this potential, detailed information on the location of each individual record of the census was necessary. To that end, digital geographic information – separately collected and compiled in 2012 by the Ministry of Agriculture and Forestry (MAF) in collaboration with the National Geographic Department (NGD) – was linked to the information in the census database.

A wide range of indicators, calculated and aggregated from the individual- and household-level census data were mapped at village level. In addition, the 2011 data was spatially linked to the 1999 data, to allow for a detailed analysis and spatial representation of trends across time and space between the two censuses.

The results, compiled in this comprehensive atlas, complement a large set of summary tabulations that have been produced and published in the Highlights of the Lao Census of Agriculture 2010/11 (ACO, 2012) and on www.decide.la, along with additional analysis of specific thematic issues published in the Lao Census of Agriculture 2010/11 – Analysis of Selected Themes (FAO, 2014).

The following limitations of the geographic analysis and presentation of the statistical data of the censuses need to be considered when interpreting the maps in this atlas:

1. The Censuses collected information from households only, meaning that agricultural production from companies is not included and represented on the maps. This is particularly important to remember when it comes to crops that are often grown in large scale by companies (such as e.g. rubber, etc.).

2. Crop production is mapped in the village in which the owner resides, assuming that the owner of the plots resides in the village where his or her land is. While this is the case in most instances, there are certainly also cases where people in urban areas cultivate land in villages beyond the one of respective residence.

3. The geographic information on the location of each village was recorded at the administrative centre of the village as a point. In the absence of official village boundaries for much of the rural areas of the Lao PDR, “village polygons” were drawn around the village points to allow a smooth geographic representation of the census data. These village areas, or village polygons, are for illustrative purposes only, and do not reflect any administrative boundaries.

The atlas is structured in four thematic sections: this brief section on the background and context of the atlas precedes a thematically structured presentation of individual variables derived from the censuses by broad thematic areas: a general geographic introduction is followed by an overview of agricultural activities, before a main chapter on crop production that follows. Crop production patterns are presented with differentiation between annual and perennial crops. The final chapter of this atlas presents the results of the geographic analysis of data on household-level livestock raising.

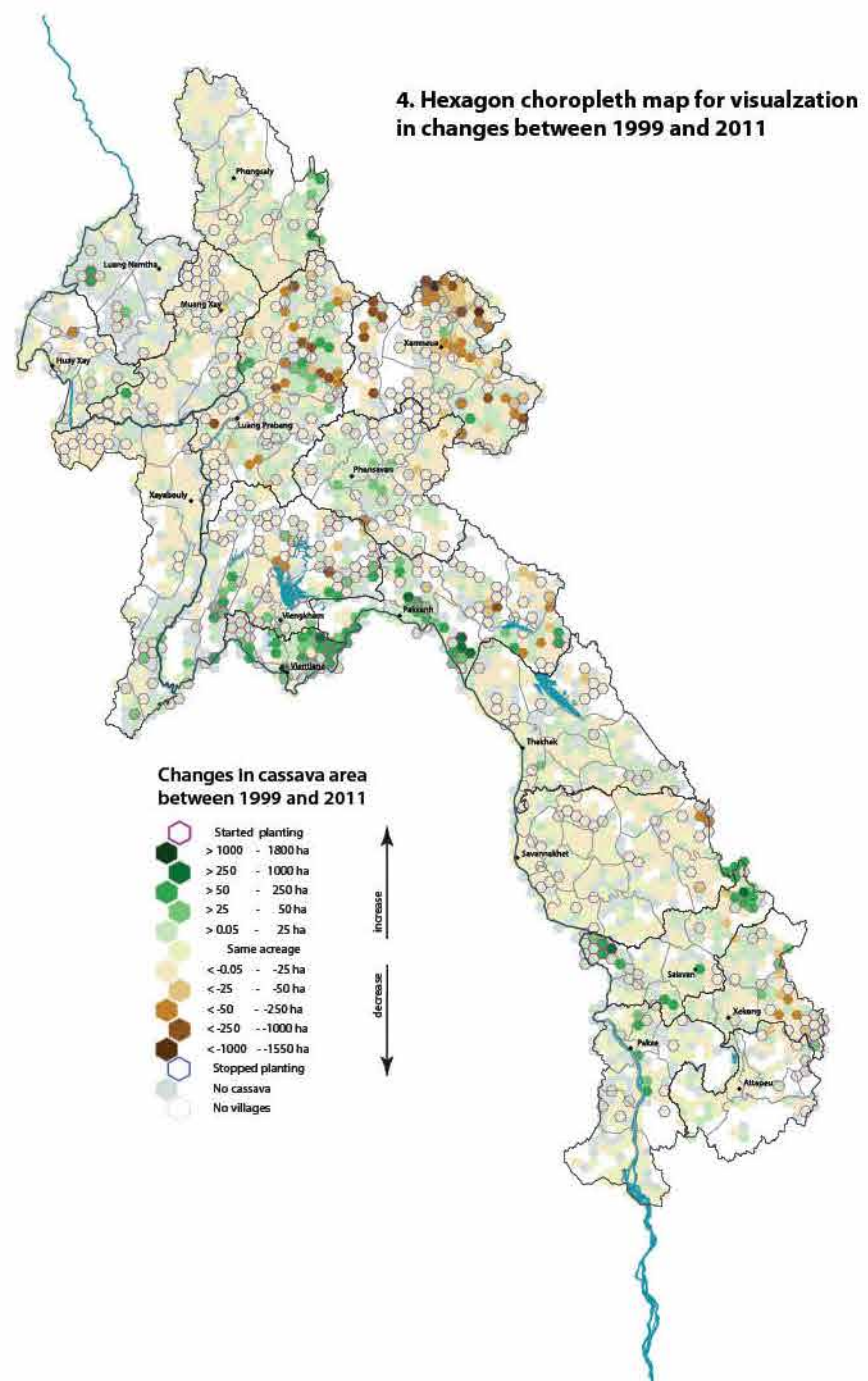
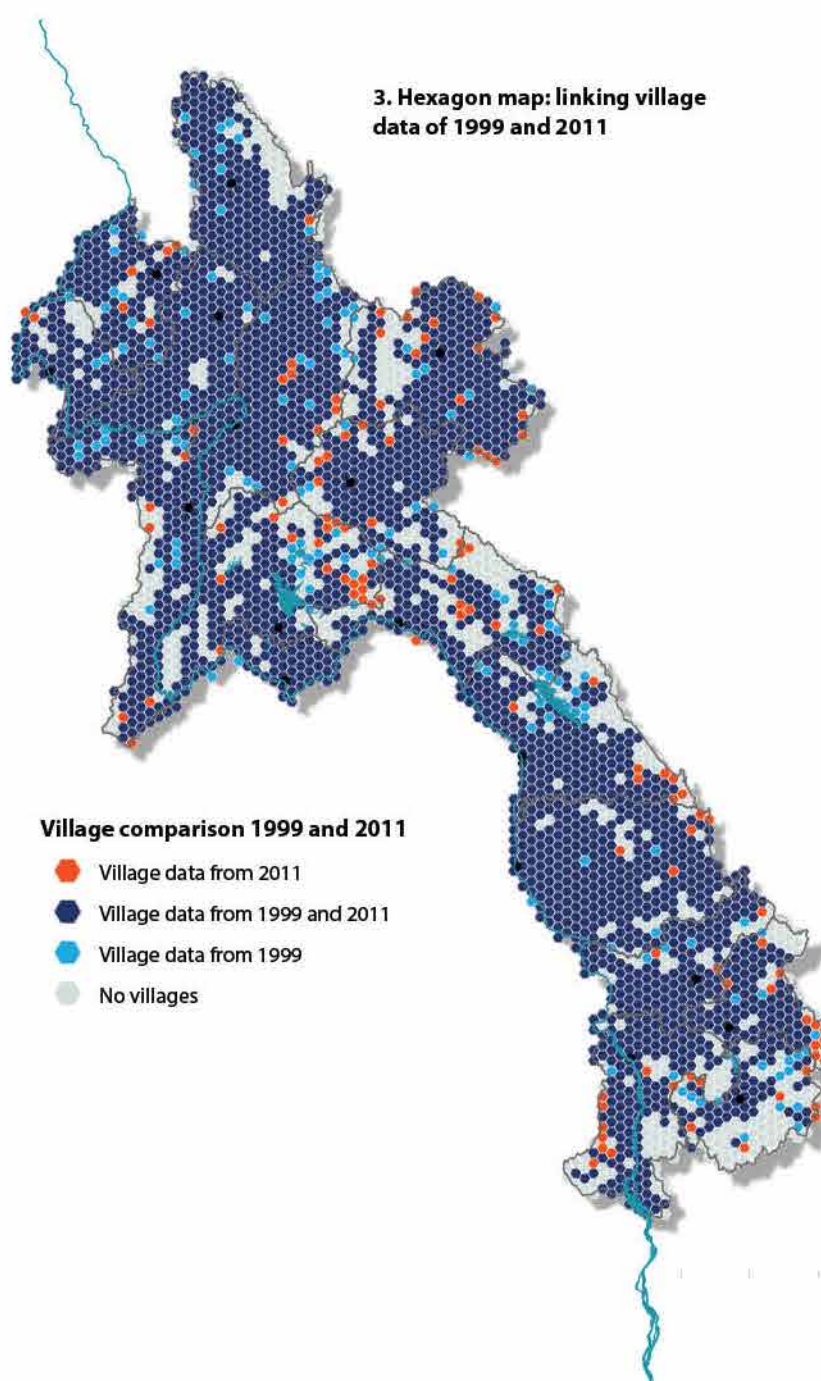
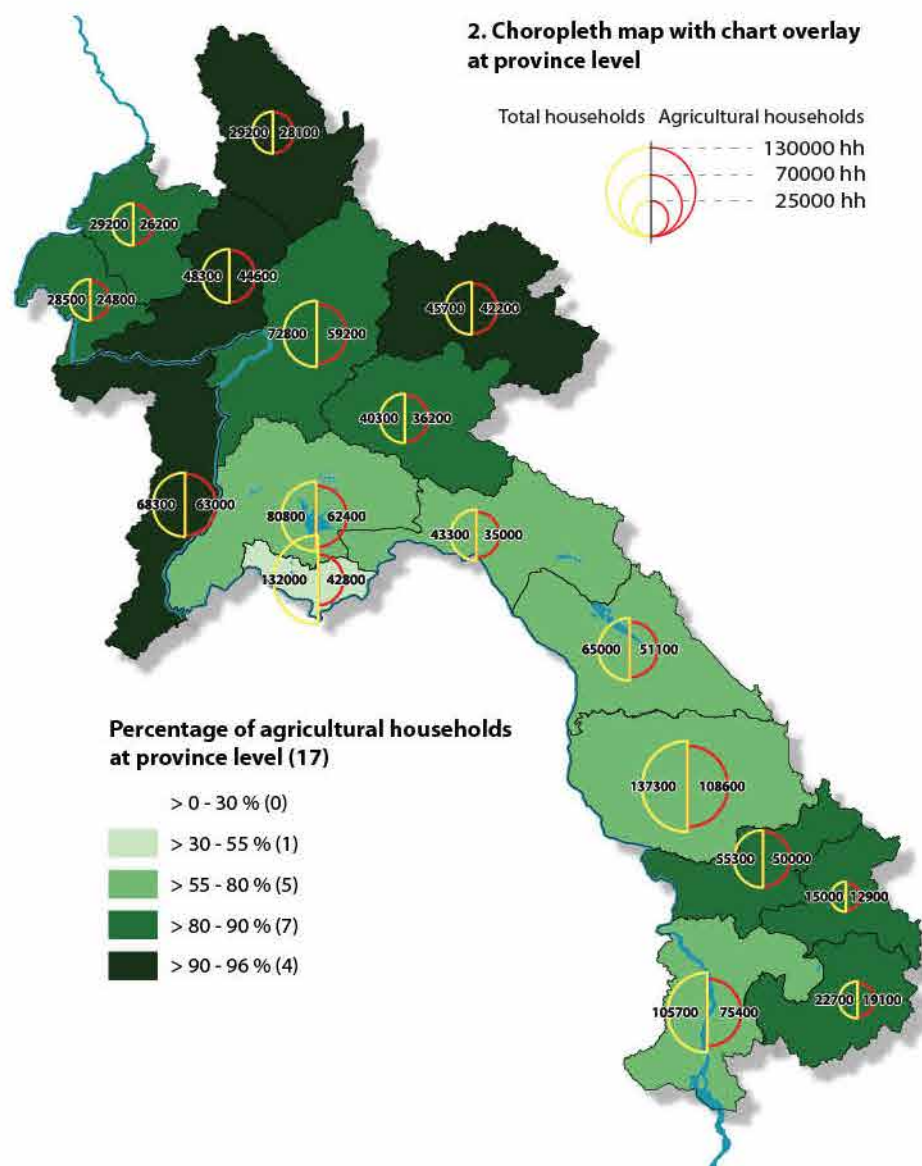
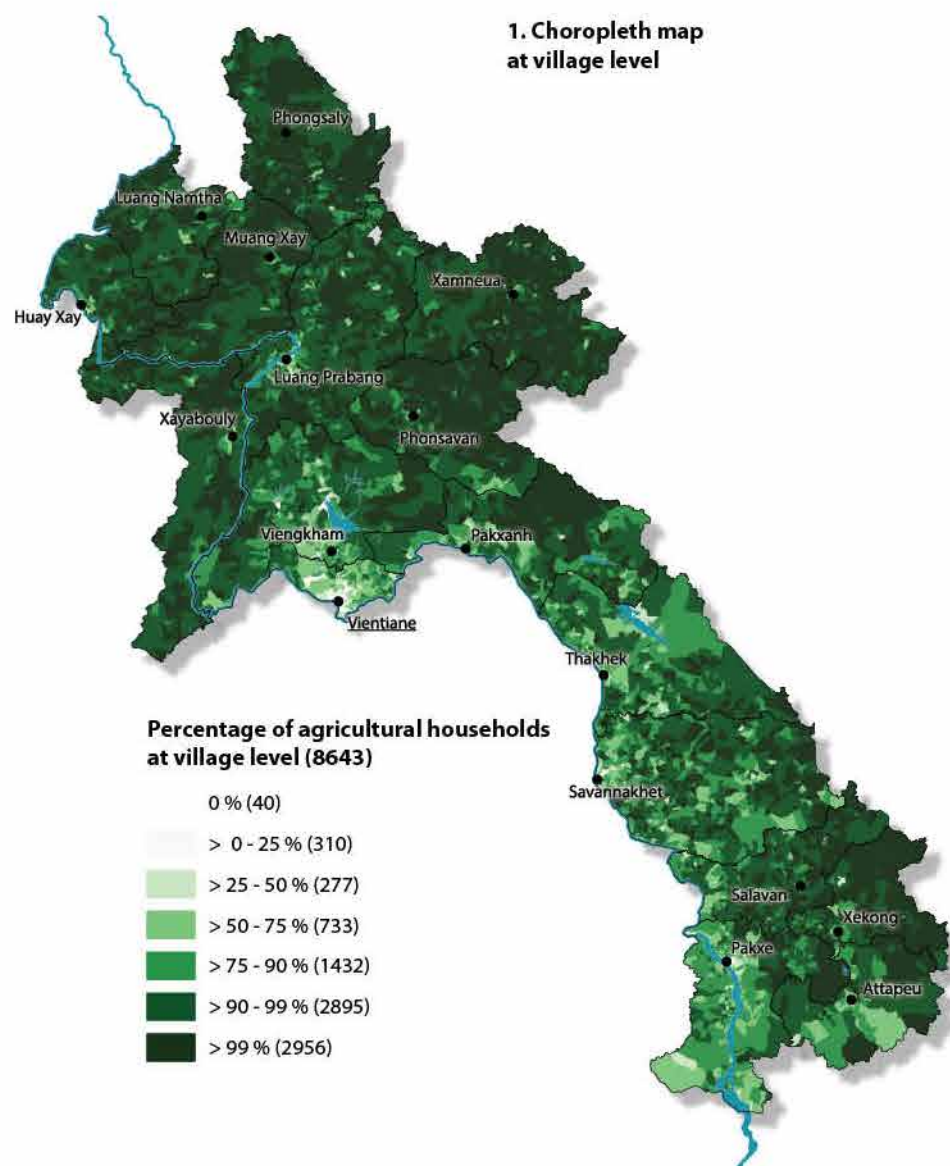
There are four types of maps used in this atlas:

1. Choropleth map at village level - The Agricultural Census 2010/11 captured the administrative centres of villages, but did not explicitly include village boundaries in part because these have yet to be defined for most villages. In the absence of comprehensive village boundaries, village polygons were generated using the factor of an equal travel distance between the village administrative location points. The village polygon thus represents the likely village area according to related GIS base data. This can lead to misinterpretations when viewing choropleth maps of village level data. The Agricultural Census data at village level was then linked to the GIS base data and the census maps of various variables at village level were generated. For these village choropleth maps, only relative numbers can be shown.

2. Choropleth map at provincial level - The provincial boundaries used are from the National Geographic Department (NGD) of the Lao PDR from 2009. The calculated Agricultural Census data at province level was linked to these provincial boundaries. Through these provincial choropleth maps it is possible to compare data across provinces. Additionally, circular and square charts are shown, which vary in size depending on the absolute numbers of the variables they represent, such as absolute number of households, area in hectares, or number of heads of livestock. The colouring used in these charts represents an additional dimension in absolute numbers. For example, the two coloured halves of the circle diagram shown indicate the total number of households (yellow) and the number of agricultural households (red). In the annual crop maps, for example, the two halves represent the dry and the wet season.

3. Hexagon choropleth map comparing 1999 to 2011 data - The hexagon choropleth maps are used to compare the 1999 and 2011 Agricultural Census data. In 1999, there were 11,126 administrative villages in the Lao PDR, whereas in 2011 there were only 8,643 administrative villages. As such, many village polygons changed (villages were resettled, merged or split) and also many village codes changed. These shifts were addressed using a “geometric method” which makes use of a regular grid of identical polygons. Village data within hexagons was aggregated separately and then compared afterwards.

4. Hexagon choropleth map - Hexagon choropleth maps are used to represent absolute numbers aggregated as hexagons of proportionate scale so that various variables such as UXO distribution or potential agricultural area can be visualized. Another variation of the hexagon choropleth maps is used to show increases and decreases in absolute numbers as in the example here of changes in the cassava cultivation area between 1999 and 2011.





NATIONAL CONTEXT



National context

Agriculture and the Sustainable Development Goals in the Lao PDR

Agriculture plays a central role as a foundation of the Lao PDR's overall national economy and development, particularly for the rural majority of the country. As such, it intersects with a number of the internationally agreed Sustainable Development Goals (SDGs). The SDGs serve as a guide and rallying-point for development throughout the Global South. The Lao PDR, like many other countries, has set for itself a number of ambitious targets for achieving the SDGs by 2030 and beyond. Those that are closely related to agriculture are numerous, including SDG 1 - No Poverty, SDG 2 - Zero Hunger, SDG 3 - Good Health and Well-Being, SDG 5 - Gender Equality, SDG 10 - Reduced Inequalities, SDG 12 - Responsible Consumption and Production, SDG 13 - Climate Action and SDG 15 - Life on Land. Understanding the current conditions of agriculture and key trends through time is essential to enable decision-makers, development agencies and rural communities to make effective, evidence-based decisions toward the attainment of these goals in the Lao PDR. Toward this end, this atlas seeks to contribute toward this basis of evidence, not only at the national-level but also, by making this information spatially explicit at the local level, enable decision-making to more effectively target development interventions where they are needed most.

The analysis of the two Censuses of Agriculture of 1999 and 2011 revealed important shifts in the agricultural sector over the 12 years. Although the number of agricultural households increased by 17 percent, the increase in non-farm households was much greater (85 percent), pointing to a general decline of the agricultural sector in the overall economy. This is to a large extent due to the on-going industrialization and urbanization processes in and around the country's main cities and towns, where many households successively transition from rural agricultural households to more households oriented toward commercial sectors outside of agriculture, continuously reducing the share of agricultural activities in their overall household economy. However, almost half of the households in areas classified as urban are engaged in farming activities.

Agricultural commercialization and exports

Although the total area of agricultural land in the Lao PDR increased by 53 percent between 1999 and 2011, from 976,000 ha to 1.49 million ha, the country still has a low portion of agricultural land compared to its neighbours, largely due to land topography, low population density, presence of unexploded ordnances (UXO), and the widespread use of forests for food collection by many rural residents.

With the increase of agricultural land and the consequent farmland availability, the average land holdings per farm household rose from 1.6 ha in 1999 to 2.4 ha in 2011. However, while only about 1 percent of households are landless, their number almost tripled between the two censuses. Among those agricultural households with land, there are important disparities in the area of holdings across Lao society. While the majority of households (65 percent) have land holdings between 0.5 and 3 ha, a disproportionate amount of land is concentrated among the top quarter of agricultural households who own more than 3 ha of agricultural land, together accounting for about 60 percent of total farmland in the country.

Although the census indicates that agriculture is mainly practiced for subsistence rather than commercial purposes, the number of households producing for the market raised considerably since 1999. The 2011 Agricultural Census revealed that 33 percent of all farm households in the Lao PDR produce mainly for market, compared to only 6 percent of farm households in 1999. Farm households in the south of Xayabouly Province and in the Bolaven Plateau area in the east of Champasak Province are particularly dedicated to market oriented agriculture. The main crops cultivated are maize in Xayabouly and coffee in the Bolaven Plateau. Agricultural modernization and the (partly) consequent productivity increment accompanied the commercialization of the agricultural sector in the Lao PDR between

the two censuses. Farmers adopted modern farming practices compared with the previous LCA. The number of farm household using fertilizer increased from 29 to 42 percent of the total farm household even if regional differences remain pronounced. Farm households reported an increment in the use of pesticides as well, while only 11 percent of farm households made use of these chemicals in 1999, 18 percent had begun using pesticides by 2011.

Lao rice is relatively expensive compared to the quality and the prices in neighbouring countries, resulting in little incentives for rice exports – irrespective of the general rice export ban that was in place during the given period.

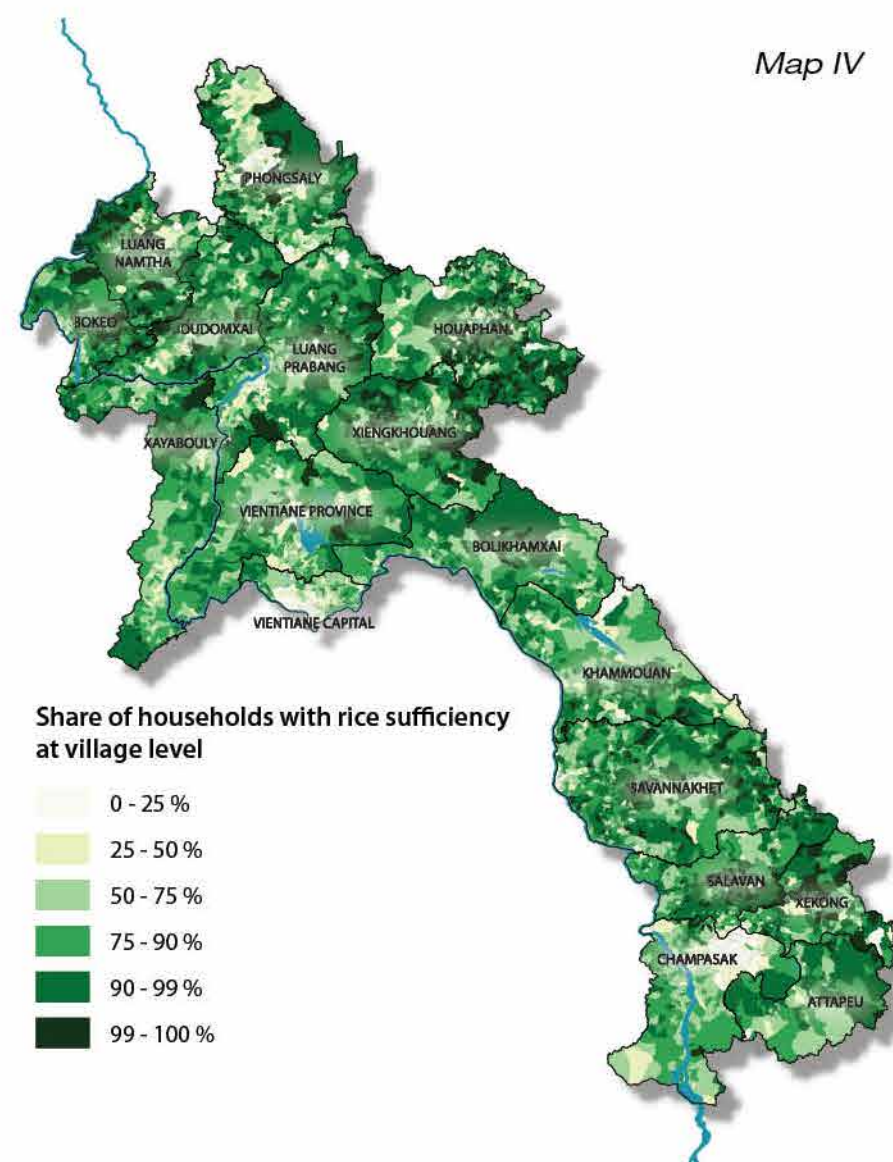
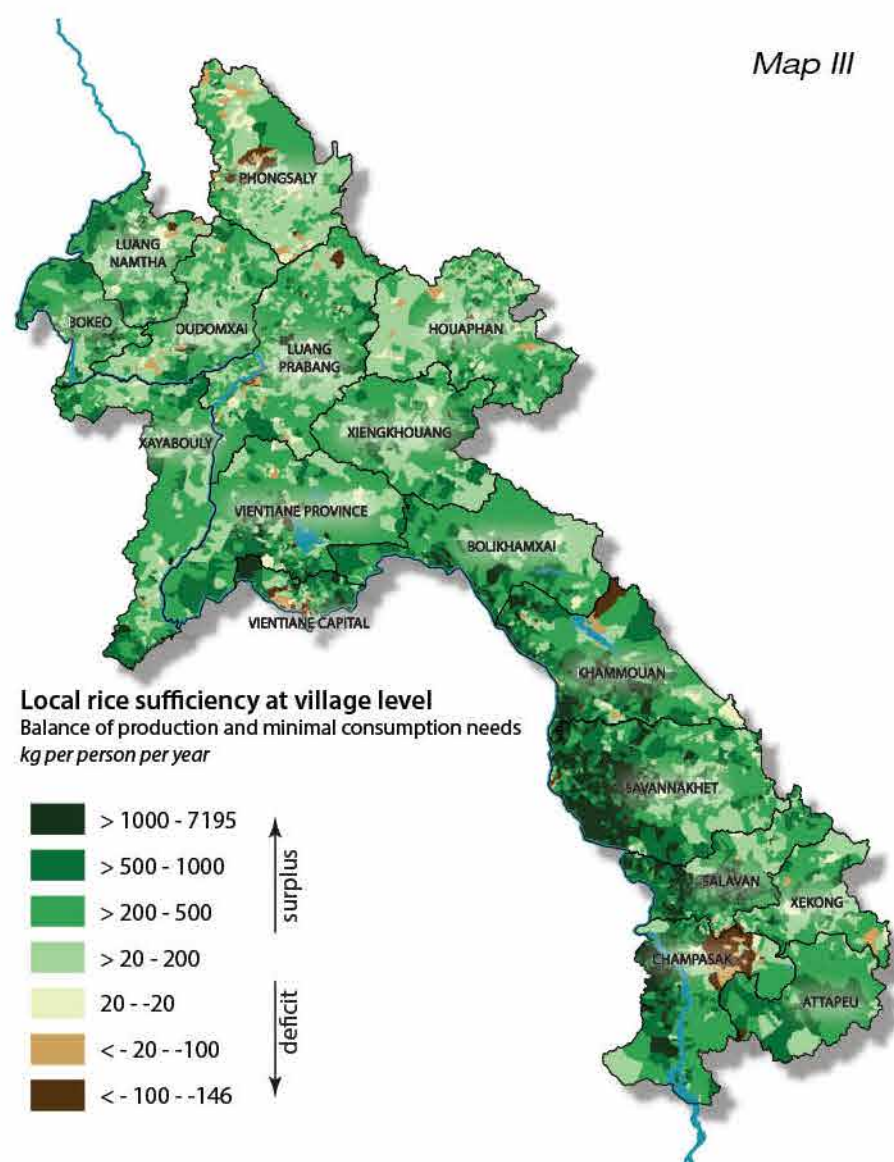
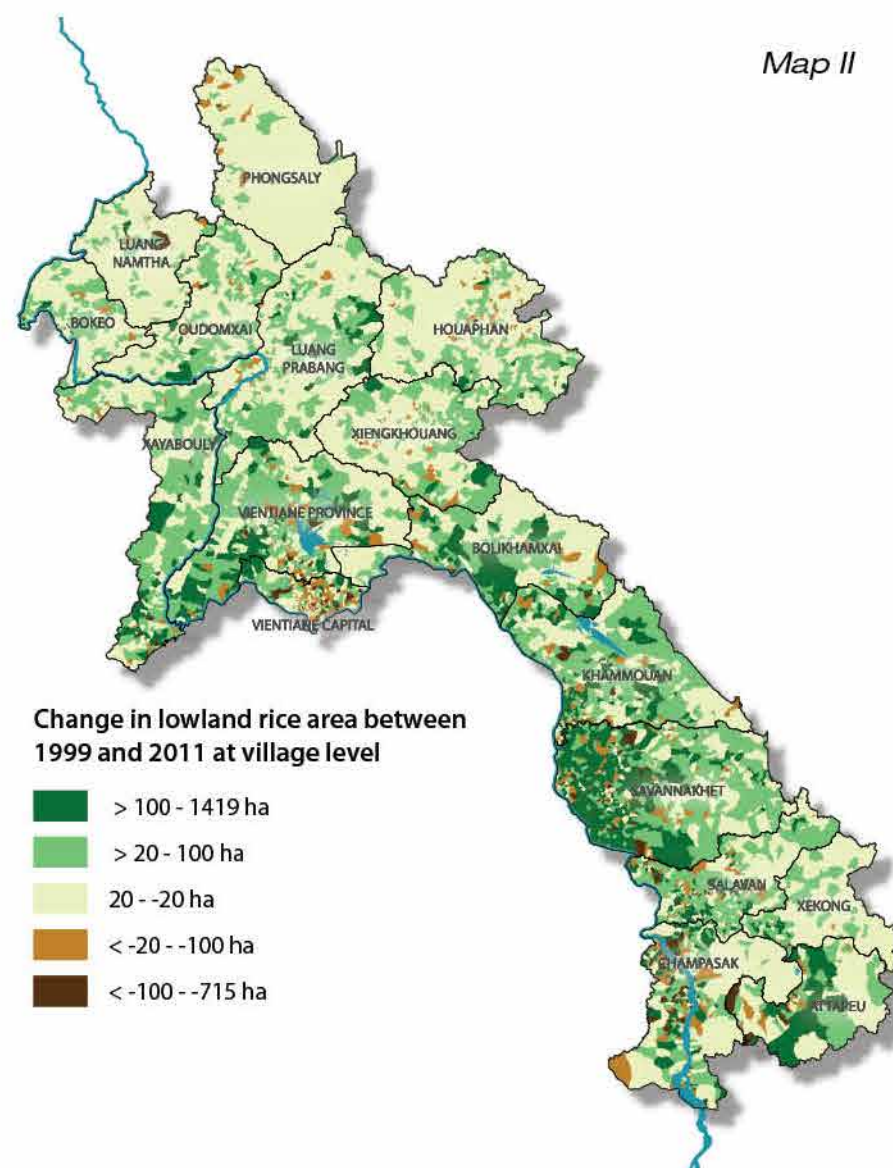
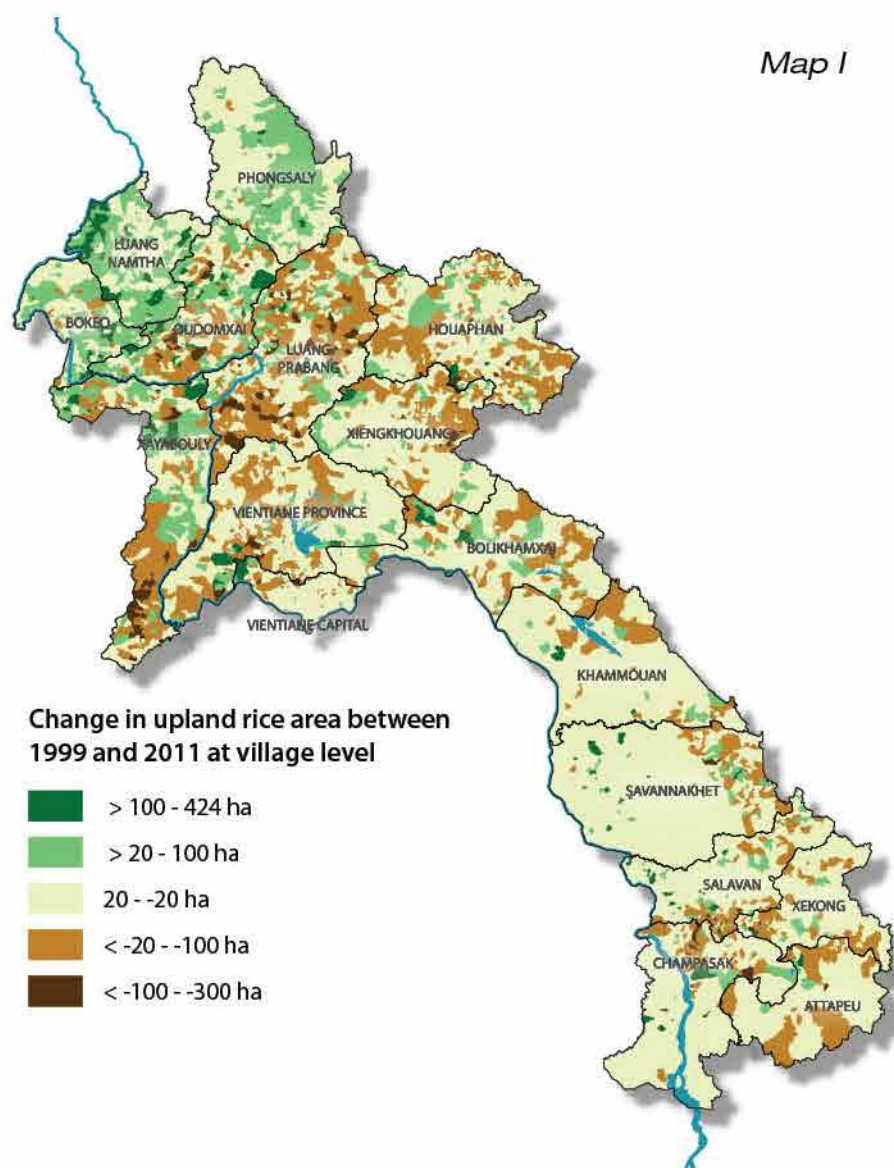
Exports of other agricultural products have grown over the years, though, accounting for 10 percent of the total export value of the country. While coffee was already an important export product of the Lao PDR in 1999, maize emerged as another major source of agricultural exports in the last decade. The expansion of maize as an export product – particularly in Xayabouly and Houaphan Provinces – is largely driven by the increase in the demand for animal feed from neighbouring countries such as Thailand, Vietnam and China.

Rice sufficiency and food security

As part of the agricultural and socio-economic transformation processes, reaching and maintaining food security for the nation's population is a high priority for the Government of the Lao PDR, emphasized in Outcome 2, Output 2 of its 8th National Socioeconomic Development Plan (NSEDPP) 2016-2020, as well as in the global Sustainable Development Goal (SDG) number 2 that aims at ending hunger, achieving food security and improved nutrition and promoting sustainable agriculture. One of the national indicators to measure progress towards this goal is enhanced food production systems and increased agricultural productivity. Food security, however, depends not only on the availability of food, but also on actual access to adequate food, utilization of available food, and the stability of the food supply. The results of the census 2011 provide insights into some of those aspects – particularly the first one. The agricultural crop production areas of the Lao farm households, and their livestock numbers provide good indicators for overall food availability.

One key achievement in the Lao agricultural sector in the years between the two censuses is the transition from a rice-deficient country to one with an overall rice surplus, reaching national rice sufficiency and even allowing for increasing rice exports. The significant increases in upland and lowland rice production areas are described and discussed in chapter C7, and illustrated in Maps I and II. Based on the census area statistics for rice, plus additional information such as average yields based on provincial statistics, total population based on household statistics of the census, and minimum daily rice consumption per person to cover minimum calorie intake, local rice production and consumption balances at the village level were calculated. The results – shown in Map III, reveal the country's rice deficit and surplus areas: The southern lowlands are the country's primary rice surplus production areas, whereas rice deficit areas naturally include urban areas where most inhabitants grow no or very little rice, along with e.g. the Bolaven Plateau, which offers favourable agro-climatic conditions for the production of higher-value crops, and where therefore little rice is grown. Most of the country's upland areas produce only a marginal rice surplus, if at all.

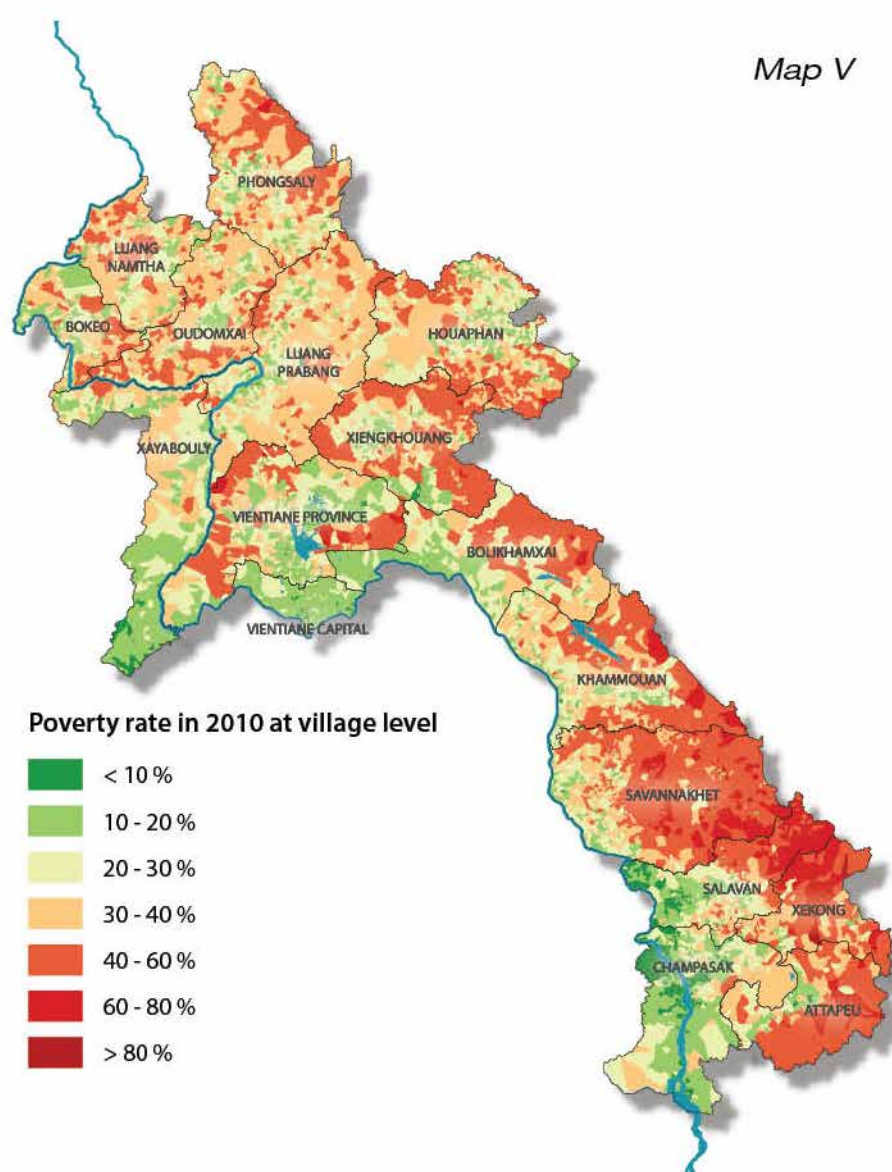
Map IV reveals the share of all households per village that produce enough rice for minimal domestic consumption needs. While the overall pattern largely mirrors the picture of overall rice sufficiency, the map reveals that even in areas with overall surplus rice production, there are many (farm and non-farm) households with rice deficits. Naturally, local rice sufficiency does not necessarily mean food security for all households in those locations, nor do local rice deficits necessarily mean local food insecurity: In many villages throughout large parts of the Lao uplands, just about enough rice is produced overall to cover the total household needs. Still, rice sufficiency at the village level is



typically not secured for many households in those areas, and minimum calorie intake requires complementing the food-plate with other staple foods such as home-grown and, in particular, forest-collected tubers, vegetables, etc. Indeed, while poor households often do not have the resources to purchase enough rice even if there is enough in the neighbourhood, households in areas that are overall rice insufficient typically have a more diverse agricultural produce range and rely heavily on forest products to attain household food-security.

Poverty and the potential in household agriculture

Closely linked to food-security is household welfare, and poverty. Ending poverty in all its forms everywhere as the first SDG in the UN development agenda is also a high priority at the national level in the Lao PDR, as stated in the country's national socio-economic development plan.



Since the introduction of the economic reforms in the mid-1980s, the Lao PDR made important progress in poverty reduction, with the proportion of poor people falling from 39 percent of the population in the mid-1990s to 27.6 percent in 2010.

About half of the country's poor live in mountainous areas and depend on agriculture and natural resources for survival (compare Map V). These areas are often cut off from the road network during the wet season, and are vulnerable to natural disasters, as illustrated in Maps A4 and B9. Often, the poorest of the poor belong to ethnic minorities and have none or very limited access to governmental and financial services.

Rice is the main crop for a majority of the – often poor – small farm households. As discussed in chapter B6, for the majority of the country's households, rice is produced primarily to cover the household's staple food needs, and only secondarily as a cash crop. An important question is therefore about the potential avenues for those farmers to increase income for improved livelihoods.

Diversification

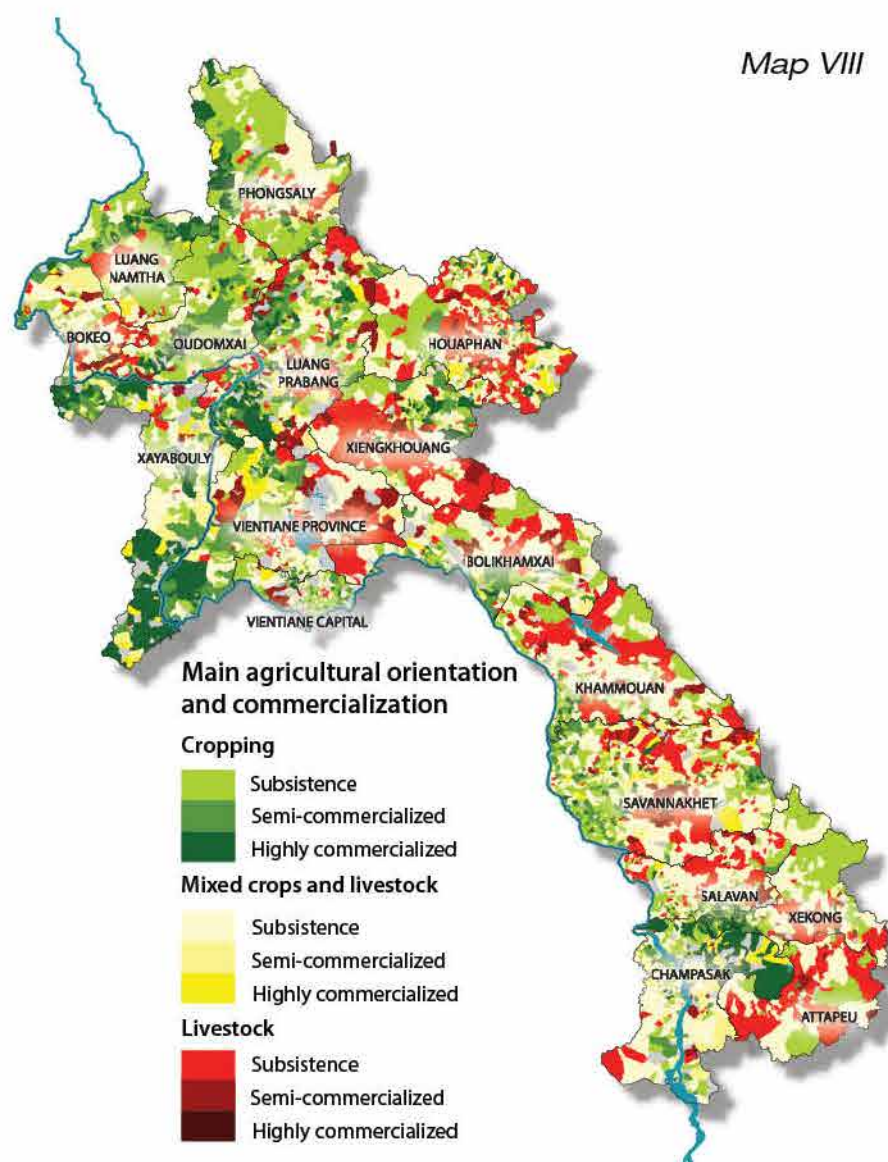
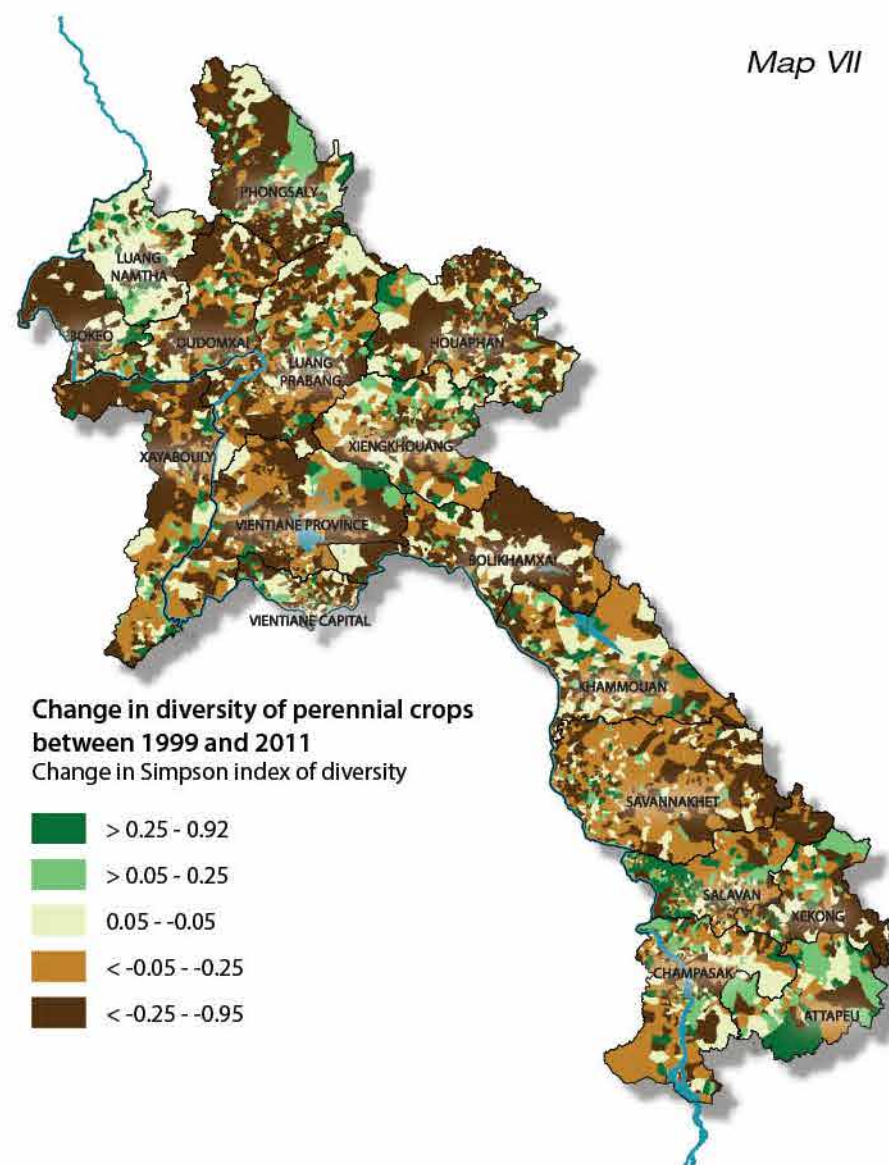
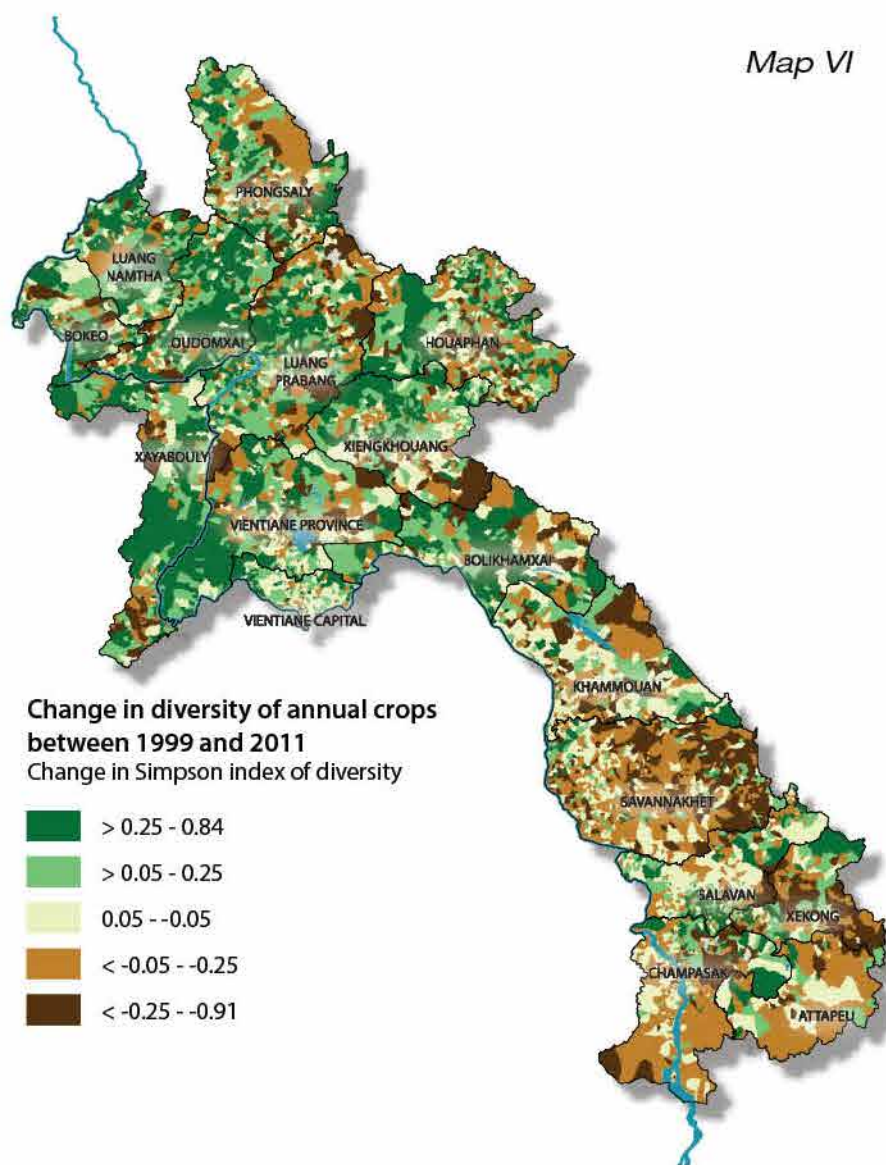
Diversification into non-rice crops is typically a farm household strategy to minimize risks of losses due to pests and e.g. price fluctuations of certain crops, and is also often seen as an avenue out of poverty through higher incomes from sales of valuable cash crops. Agricultural diversity is fundamental to the resilience of agricultural systems and rural communities to such and other changes, including those arising from global climate change.

The two censuses of agriculture reveal important respective changes in the household-based agricultural production patterns over the 12 years period. While there was an overall increase in the diversity of annual crops grown by farmers, the diversity of perennial crops has decreased significantly (compare Maps VI and VII). Distinctive regional differences can be identified in those trends, though: the diversity of annual crops has increased in most villages of the northern and the central part of the Lao PDR, where poverty rates declined significantly in the first decade of the 21st century. That diversity decreased, however, in many villages of southern Lao PDR, particularly the eastern part of Savannakhet and Salavan Provinces, where poverty incidences remain high and the least progress in improving livelihoods has been made in recent years. Rice was the dominant annual crop throughout the Lao PDR in 1999. In many villages of the lowlands of the north, however, a shift from rice towards other annual crops can be observed between 1999 and 2011, particularly in southern Xayabouly, as well as in other smaller parts of the north, such as non-rice annual crops dominate the annual crop landscape in 2011, largely due to the increases in maize and Job's tears. Pretty much the inverse happened throughout the southern Lao PDR (with the exception of the Bolaven Plateau, where rice is not a main crop), where rice became even more dominant within the annual cropping landscape.

The declining diversity in perennial crops is observable throughout the country, except for areas where there was already a very low diversity in 1999, such as in Luang Namtha Province and the Bolaven plateau. Overall, the share of land under perennial crops in total agricultural area has declined in favour of greater expansions in areas under annual crops. Significant exception to this trend can be observed in much of Luang Namtha Province (mainly rubber), and the northern and western parts of Bokeo (rubber) and Phongsaly (rubber, tea, and cardamom) Provinces respectively, in smaller parts of Oudomxai and Vientiane Provinces (rubber), as well as on and around the Bolaven Plateau (coffee), where the share of perennial crop land in total agricultural land strongly increased.

Agricultural land use and production patterns

The agricultural census provides a detailed picture of farm household's land use for agricultural production based on the area figures per crop, as well as on the importance of livestock raising, based on the number of animals per household. In order to get an idea of the economic importance of different crops and livestock in different areas of the country, the area- and livestock number based information would need to be translated into their respective commercial values. Using the census statistics on areas, livestock numbers, as well as the households' degree of commercialization, together with provincial statistics of average yields and farm-gate prices, the production values of crops and livestock and the general commercial orientation was calculated at the village-level. The results reveal the general household production orientation in terms of livestock versus crops, as well as the degree of respective commercialization in the different parts of the country (Map VIII). While clearly in many of the country's villages subsistence crop production is predominant, there are still distinctive areas with significant commercial crop production, as well as such with a stronger focus on – mostly subsistence-based - livestock household production systems.





INTRODUCTION

A1 Perspective from space

This map displays a natural colour satellite image of the Lao PDR and parts of the surrounding countries. It was taken from the Google Earth 5.0 historical imagery at the end of the wet season of 2010, which is based on an ortho-rectified, mosaicked and colour-balanced Landsat-7 image. It shows the basic categories of land cover, provincial and district boundaries, as well as water sources.

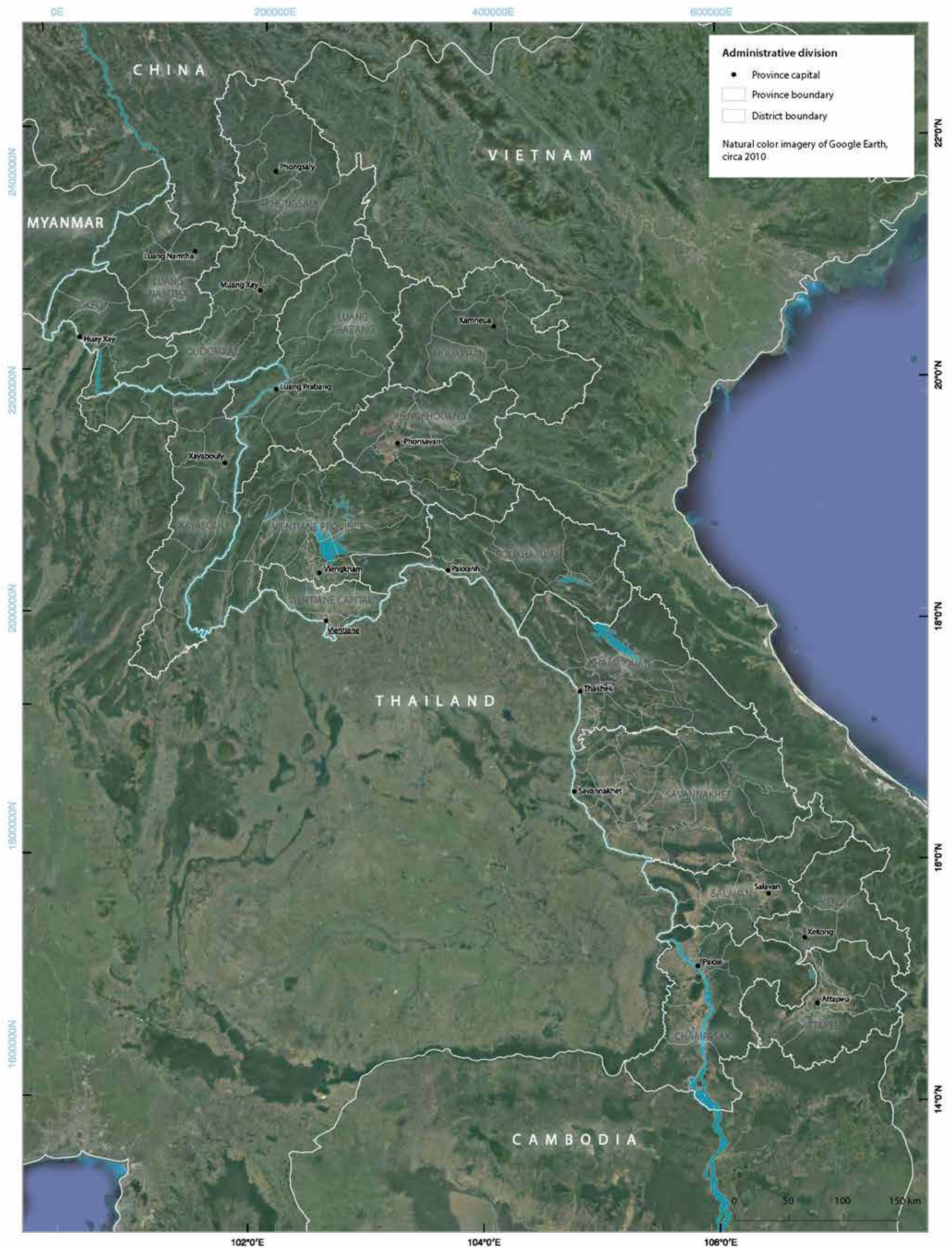
The topography of the Lao PDR is characterized by two main geographical zones – the central plains along the Mekong River and the mountainous regions to the north and along the eastern border with Vietnam. The country is rich in natural resources such as minerals, water, and forests. This image shows its extensive forest coverage, which is visibly higher than that of the neighbouring countries. At the end of the wet season, the country is at its greenest; the northern regions as well as the Annamite Mountain Range along the border with Vietnam especially embody this abundance. The different shades of green indicate biomass density, where darker shades of green indicate higher density. The green turns into ochre for agricultural land, irrigated areas, urban centres and mines.

Although agricultural land accounts for only 7.9 percent of the total land area of the Lao PDR, the agricultural sector employs more than 75 percent of the country's labour force and contributes up to 26 percent of the GDP (FAO, 2014). More than 60 percent of the agricultural land (including perennial crops, annual crops and permanent pasture land) is dedicated to rice cultivation, while other important economic crops include maize, coffee, sugarcane, cassava and industrial tree crops such as rubber, teak, eucalyptus, acacia and agarwood.

The percentage of urban households in the country has reached 31 percent and engagement in non-farm economic activities has increased. Still, nearly half of all urban households remain engaged in agricultural activities, maintaining links with the agricultural sector.

The light blue colour on the map indicates rivers, bodies of water, and hydroelectric dam reservoirs. The Lao PDR has historically had most of its largest settlements centred around waterways, thus the country's major urban and economic centres today (Vientiane, Pakxe, Savannakhet and Luang Prabang) are located along the Mekong River. The river supports economies and livelihoods throughout its entire basin, functioning as a lifeline for the whole nation and the entire Mekong Region. Regionally, it serves as a commercial route connecting the Lao PDR with its neighbouring countries through bridges and navigable waterways; it generates energy and revenue via hydro power projects and its fisheries provide a stable source of protein, thus contributing to food security.

The ongoing integration of the Lao PDR into the ASEAN Economic Community, combined with the economic impacts of growth in neighbouring ASEAN countries and China, have generated high demand for the Lao PDR's natural resources.



A2 Relief, climate, and transportation networks

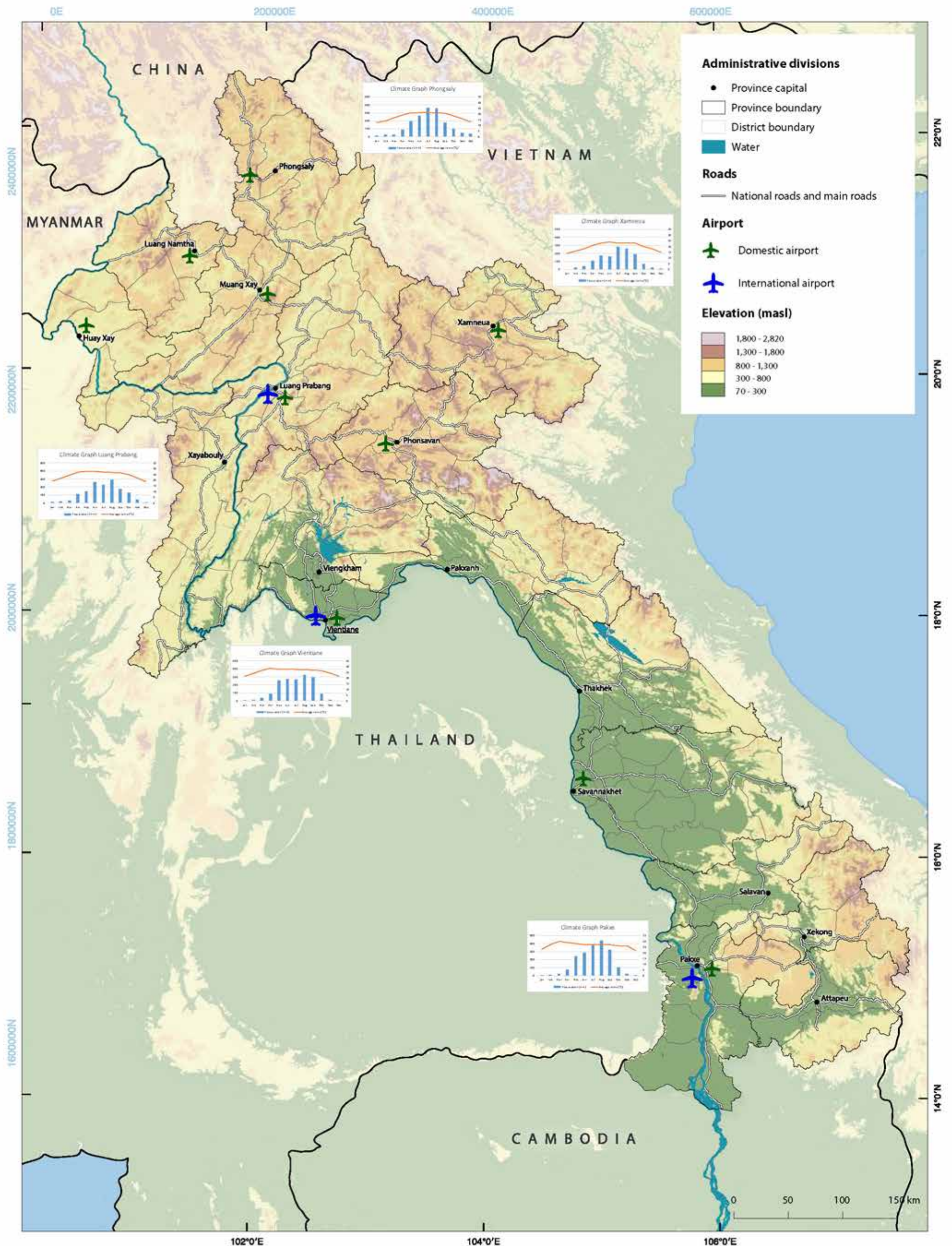
The Lao PDR is situated in Southeast Asia, in the heart of the Indochinese peninsula, at a Latitude of 14 – 23° N and longitude of 100 – 108° E. Its topography can be divided into three main categories: uplands, lowlands and plateaus. The uplands or plateau regions cover around 75 percent of the country's surface. The highest peak is Phou Bia Mountain at 2,820 metres above sea level (masl) in Xiengkhouang and the lowest point is 70 masl along the Mekong River in Champasak Province, near the Cambodian border.

Northern Lao PDR is highly mountainous. The Annamite Mountains run from the northwest to the southeast of the country, largely along the Vietnam border. Plateau areas are found mainly in Xiengkhouang Province, in Khammouan and in Champasak. The lowlands encompass around 25 percent of the country's area and stretch from Vientiane Capital, along the Mekong River, and south to the Cambodian border.

The climate of the Lao PDR ranges from subtropical to tropical. Under the Köppen climate classification system, it is classified as *Am* (tropical monsoon climate), *Aw* (tropical wet savanna climate), and *Cwa* (monsoon-influenced humid subtropical climate). Two defined seasons characterize the Lao PDR's climate: the dry season and the wet season. The dry season begins in November and lasts until April, while the wet season runs from May through October. The five climate graphs on the map illustrate monthly precipitation as well as monthly

average temperature in different areas of the country. The graphs demonstrate how rainfall increases during the wet season and is heavier in the regions around Pakxe and Phongsaly. While the majority of the Lao PDR experiences warm temperatures year-round, some areas of Phongsaly and Houaphan reach much colder temperatures during the dry season than the rest of the country due to their higher altitudes.

The map also shows the national and main road network. The Lao PDR is a landlocked country, thus it depends greatly on road transport for economic development. In recent decades, the expansion of the road network has been followed by a substantial growth in the number of vehicles across the country. However, remote areas still experience minimal traffic due to the low volume of economic activity occurring there. Despite significant improvements in the road network quality in the last decades, many roads are still in poor condition. Waterways are another important means of transportation in the Lao PDR, and the Mekong and Nam Ou Rivers are important natural channels for large-draft boat transportation. Finally, ten airports have been built in the Lao PDR, three of which offer international flights: Vientiane Airport, Luang Prabang Airport and Pakxe Airport.



A3 Administrative divisions

The Lao PDR is a landlocked country located in the heart of Southeast Asia, with a geographical area of 236,800 km². It is bordered by China to the north, Vietnam to the east, Cambodia to the south, Thailand to the west and Myanmar to the northwest.

This map shows the administrative divisions of the Lao PDR as of 2011, including provincial and district boundaries, with their respective capitals, bodies of water, national roads and other main roads. The district codes illustrated on the map are also listed on the bottom left with their respective district names. The Lao PDR is divided into 16 provinces (referred to as *khoueng* in Lao language) and one prefecture (*kampheng nakhone*), also known as Vientiane Capital (*nakhone luang viengchan*). The provinces are then divided into 143 districts (*meuang*) which are the secondary administrative divisions. The lowest administrative units are villages (*ban*), of which there are 8,643 in total.

The number of districts and villages has changed since the establishment of the Lao PDR. These changes were part of a process driven by the Government of the Lao PDR's (GoL's) stated aim of improving accessibility and providing effective administrative governance as well as socioeconomic and cultural development through strategic use of its limited resources. The Population and Housing Census of 2005 reported 133 districts and over 11,000 villages. As a result of these processes of rural restructuring the total number of districts increased to 143 by 2011, while the number of villages decreased to 8,643, largely through consolidation and resettlement. Vientiane prefecture, once part of Vientiane Province, was formed in 1989. To address security issues, Xaisomboun Special Zone

(*khetphiset*) was established in 1994 by merging parts of Bolikhamxai, Vientiane and Xiengkhouang Provinces. Xaisomboun Special Zone was dissolved in 2006 and its districts transferred to Vientiane and Xiengkhouang Provinces. In 2013, Xaisomboun Province was re-established.

The most populous province is Savannakhet, which also has the largest area at 21,775 km². Vientiane Capital is the second most populated (with 820,940 inhabitants) and has the highest population density, with 180 inhabitants per km². Xekong Province is the least populated, with only 113,048 inhabitants and a population density of 11 inhabitants per km².

Vientiane Capital has been the capital of the country since the 16th century. The metropolitan area is home to the national government's administrative offices, foreign embassies and many major businesses. Due to the high rate of urbanisation, Vientiane Capital has experienced a significant population increase during the last decades, with an average population growth rate of 3.1 percent per year between 1985 and 2005 (JICA, 2011).

The provincial and district boundaries do not always align with natural geographic features such as rivers, streams, mountain ridges, valleys, and so on. This is because the boundary delineation process was mainly based on the history of administrative governance ties and mutual agreement between districts and provinces, rather than geographic features.



A4 Accessibility of villages

The map indicates overall road accessibility at the village level, along with provincial and district boundaries, and provincial capitals. Year-round access is concentrated mainly in the lowland areas along the borders with Thailand. Even though more than 65 percent of villages have year-round road access, many other areas are still only accessible in the dry season and some villages are not accessible by road at all throughout the year.

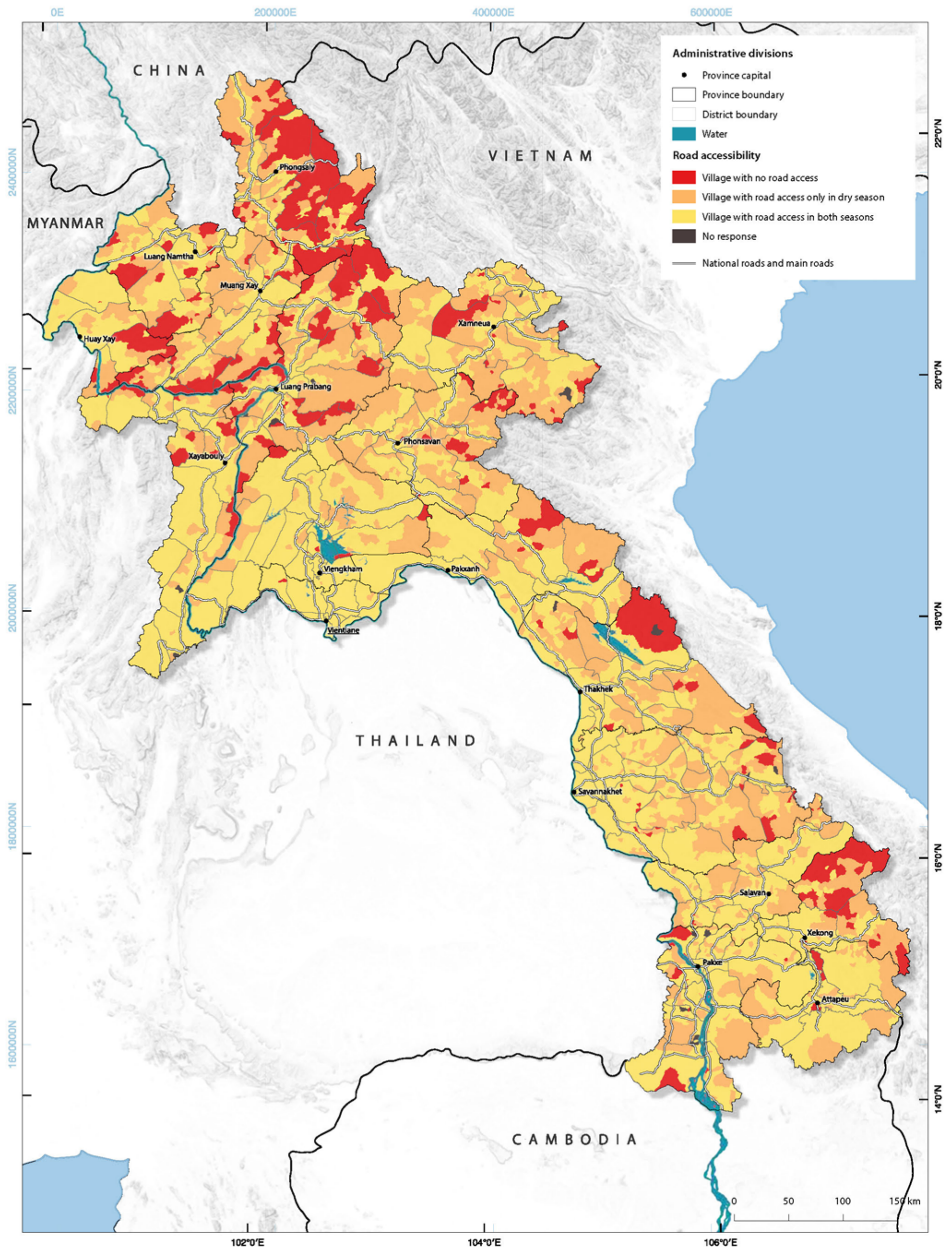
More remote areas, indicated in red, are located primarily in the north, along the eastern border and near major mountain ranges, including western and southwestern Luang Namtha, southeastern Bokeo, southern Oudomxai, the hilly areas of Luang Prabang, northwestern Houaphan, eastern Bolikhamxai and the majority of Phongsaly Province. The eastern part of Khammouan, northeastern Xekong and Salavan adjacent to border with Vietnam and southern Champasak are difficult to access as well. The geographical features of these places limit the development of a solid transportation network. In addition to road access limitations because of difficult terrain, large parts of the National Biodiversity Conservation Areas (NBCAs), are inaccessible by road due to conservation-related regulatory measures. Orange indicates the areas accessible by road only in the dry season. Seasonally accessible villages are commonly found in northern and eastern Lao PDR and along the Annamite Mountain Range. In yellow are the most accessible areas, mainly located on the west side of the country, along the main highways and the Mekong River. The road connections in these areas facilitate trade with neighbouring countries via east-west and north-south economic corridors.

More than 75 percent of the Lao PDR is mountainous and relatively rich in water resources, with many rivers and small streams. 90 percent of the country's area is located in the Mekong River Basin, while roughly 25 percent of the entire Mekong River Basin itself falls within the territory of the country (FAO, 2016). Despite the many benefits of Lao PDR's abundant water resources, the density of rivers and streams also presents an obstacle to the modernisation of road-based transportation networks. Inaccessibility due to the mountainous terrain and dense river networks is further exacerbated by low population densities and an abundance of small, dispersed rural communities, making infrastructural and commercial investments costly.

Due to the frequent occurrence of natural disasters such as flash floods, landslides, and storms, maintenance of the road network is necessary - and costly - throughout the year. Due to budget limitations, road damage from natural disasters often goes unrepaired, cutting off remote villages and creating challenges for delivering assistance.

It is important to highlight that this map specifically indicates differing degrees of domestic road access, but it does not account for accessibility through other modes of transportation or accessibility from other countries. People living along the Mekong River and some of its tributaries may, for example, also use water as means of transport; and border regions may be well-connected to markets in other countries while being relatively disconnected from domestic services and economic infrastructure.

A4 Accessibility of villages



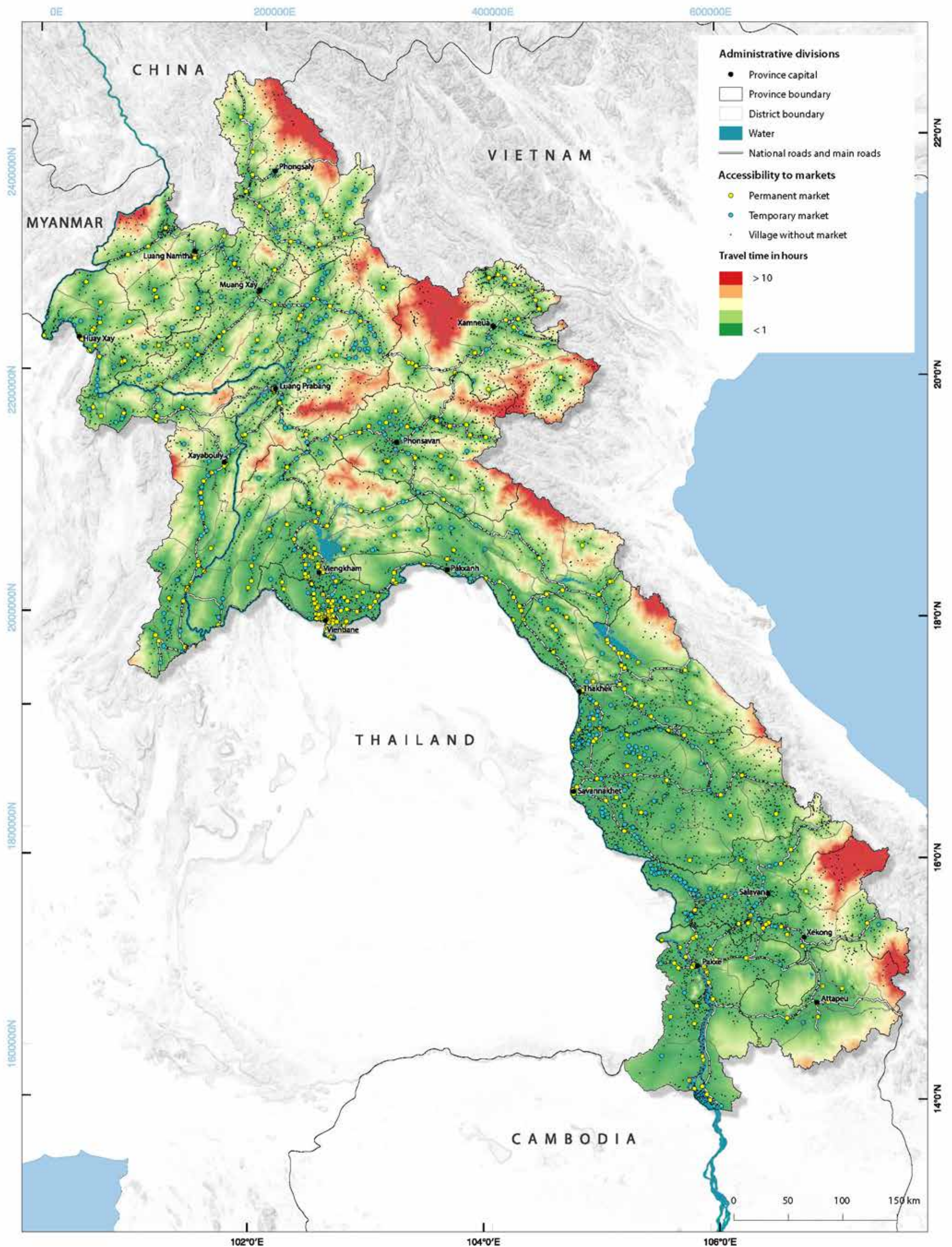
A5 Accessibility of markets

The market is the physical place where production meets consumer demand. In developing countries, markets create income-generating opportunities and can contribute to poverty and hunger reduction. Adequate market access is of crucial importance for farmers because markets allow them to acquire farm inputs and farm services and to deliver their agricultural produce to potential buyers.

This map illustrates the accessibility of markets in terms of travel time. The colour ranges from green to red to show the travel time from a specific location to the closest market. The regions shown in green enjoy quick and easy access to markets, whereas for those coloured red it takes 10 hours or more to reach the nearest market. Market locations are distinguished by those that are permanent markets (yellow) and temporary markets (blue).

Markets tend to be located in provincial and district capitals, areas close to national and main roads, and the lowlands in general, especially in the Mekong River Plain. The density of markets is highest in the Vientiane Capital City area. In mountainous regions and regions with limited road access, indicated in red on the map, reaching a market can be difficult.

Around 150 to 200 villages are located in these difficult-to-reach areas, where most inhabitants engage in subsistence-based agriculture and only sporadically sell their surpluses to markets.



A6 Main land types

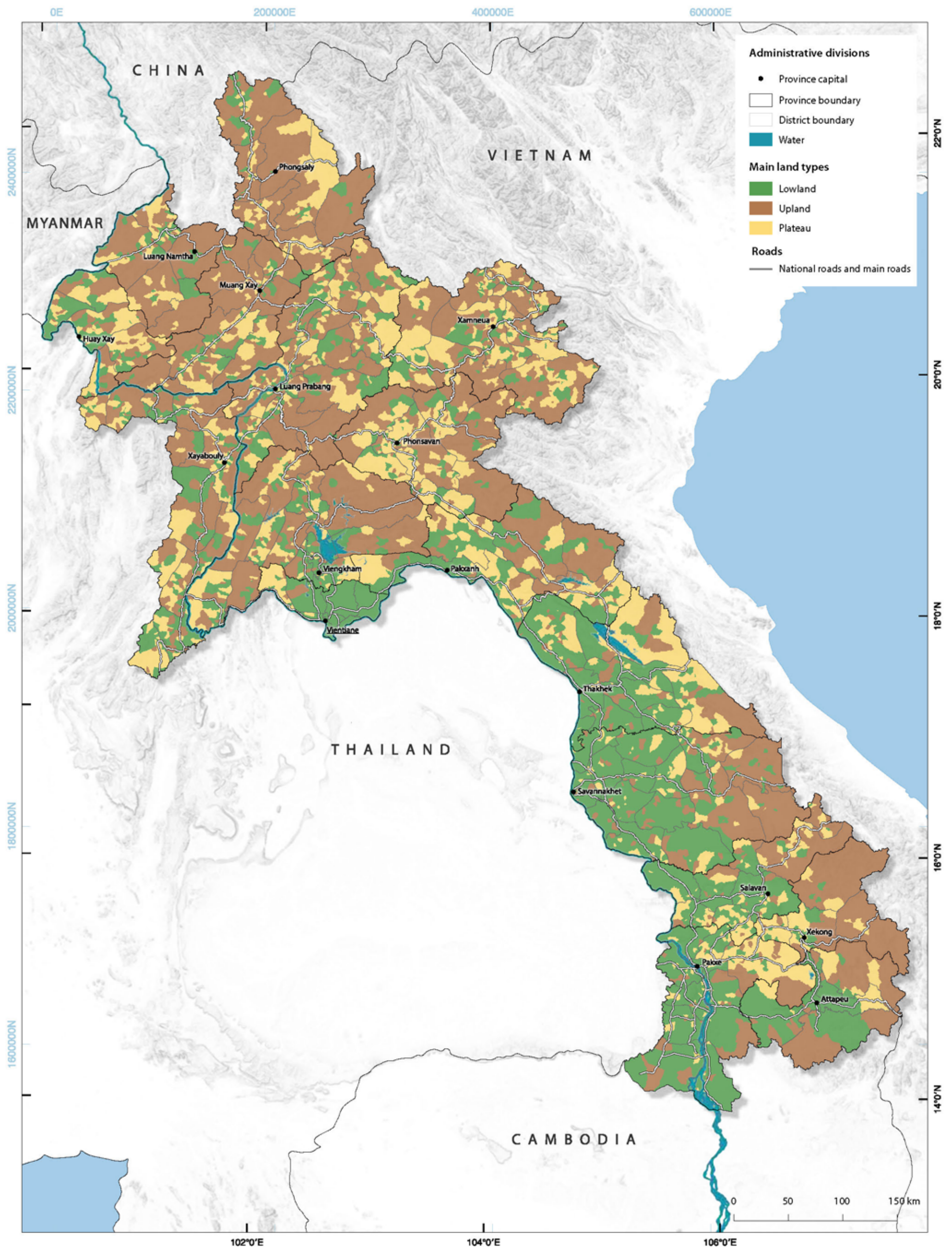
This map illustrates the three main land types present in the Lao PDR, which relate primarily to the slope of agricultural land. The green colour indicates lowland areas, primarily located along the Mekong River. The brown colour indicates upland areas, which dominate the northern and eastern parts of the country. The yellow colour shows the plateau areas located between the uplands and the lowlands.

The GoL organizes development planning around three general land types: the lowlands, the uplands, and the plateau areas. The lowlands are characterized by rain-fed and/or irrigated farming along the Mekong River and its tributaries where crops are cultivated mainly for commercial purposes. The most common crops cultivated on this type of land are rice, maize, cassava, sugarcane, soybean and banana. In the uplands, which are found primarily in the northern and eastern mountainous regions, the population engages more commonly in shifting cultivation, agroforestry and tree plantations. The GoL considers many traditional forms of shifting cultivation to be damaging to the environment and soil nutrients, resulting in a number of policies historically aimed at eradicating shifting cultivation practices, and more recently toward stabilizing and reducing the area under shifting cultivation. Rubber has been proposed as an alternative to shifting cultivation and has been promoted widely, with mixed results. The plateau and shallow slope areas are mainly used for the production of maize, cardamom, coffee and tea.

The Agricultural Development Strategy to 2025 and Vision to 2030 aim to promote commercial agricultural production and increase the export of cash crops. Rice production for export is especially encouraged in the central and southern lowland areas, e.g. in Khammouan, Savannakhet, Salavan and Champasak. Coffee is encouraged on the Bolaven Plateau in Champasak, Salavan and Xekong. The volume of tea production has also increased significantly in the upland areas of Phongsaly and in the plateau areas of Xiengkhouang. The high volumes of maize produced and exported from Bokeo, Oudomxai, Xayabouly, Xiengkhouang and Houaphan to neighbouring countries is one of the key achievements of the commercialization policy.

It is important to note that there are limitations to categorising the main land types by topography only, as land use practices and priorities are highly diverse and differ from area to area within the country.

A6 Main land types





AGRICULTURAL OVERVIEW

B1 Agricultural land

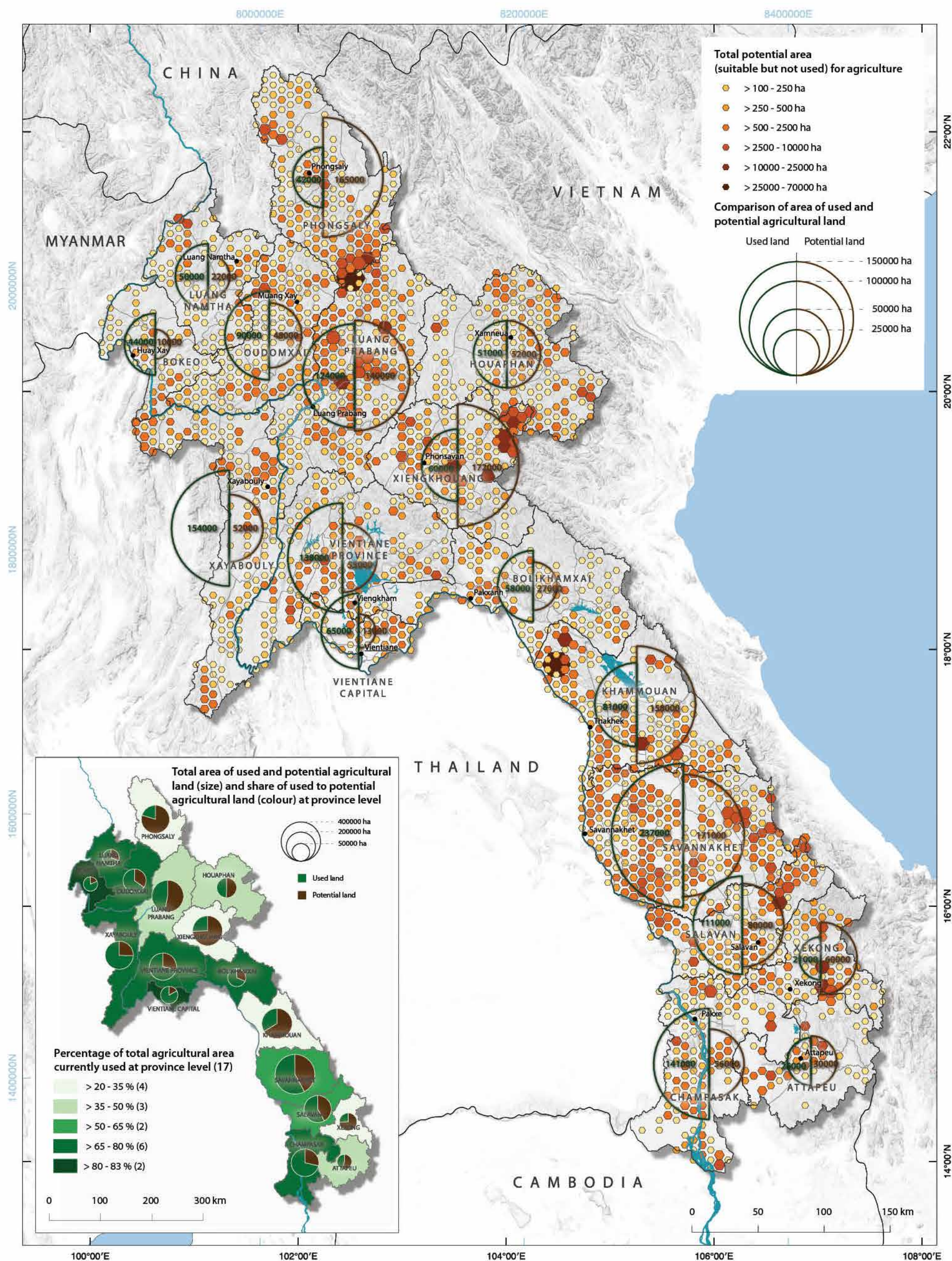
Agricultural land refers here to the share of the country's total land area that is arable, and is used to produce annual crops, to cultivate permanent crops, or as permanent pasture. The total area of agricultural land in the Lao PDR increased by 53 percent between 1999 and 2011, from 976,000 ha to 1.49 million ha. The proportion of agricultural land increased from 4.4 to 7.9 percent of the country's total land area.

Despite this increase, the Lao PDR still has a low proportion of agricultural land compared to neighbouring countries. In Cambodia, for instance, the area used for agricultural production is 31.5 percent of the country's total area, in Thailand 38.7 percent, in Myanmar 19 percent, and in Vietnam 33.1 percent (FAO, 2014). This low percentage is due to its mountainous terrain, low population density, lack of capital investment for agricultural conversion and government policies relating to forest conservation. Further, since the Lao PDR has limited infrastructure, this also partially limits agricultural expansion in some areas. The presence of unexploded ordnances (UXOs) dropped during the American bomb raids of the 1970s are also a limiting factor in many areas. UXOs affect all provinces in the country and the most affected lands are often left unused due to the risks posed by cultivation and development. Agricultural land area calculations also underestimate areas used for shifting cultivation, as many fallows are classified as forest land in the 2010/11 Agricultural Census, despite being an integral part of shifting cultivation, used for cultivating fallow species, including a high diversity of Non-Timber Forest Products (NTFPs).

This map also shows the total potential area, suitable but not currently used for agricultural production, and compares it to the amount of agricultural land. Thus the label, "potential area suitable for agriculture" refers to land that is suitable for cultivation but is not cultivated. These areas include the land affected by UXOs, bamboo forests, and other types of uncultivated land. The smaller map places focus on the provincial level, highlighting the ratio between used and potential agricultural land.

In northern Lao PDR there are relatively large areas of potential agricultural land. In the provinces of Phongsaly and Xiengkhouang particularly, used land accounts for 25 and 34 percent of the total potential area for agriculture respectively. The large ratio of potential to used agricultural land in Phongsaly may be related to the province's poor access to transport networks, markets and government services. Xiengkhouang Province has the largest area of unused but potential agricultural land, with 172,000 ha of potential agricultural land. This is not surprising, given the large amount of UXOs in the province, which have been an obstacle to its agricultural development. Other UXO-affected provinces (e.g. Savannakhet, Khammouan and Xekong) also have relatively large areas of potential agricultural land (171,000, 158,000 and 60,000 ha respectively), suggesting a causal relationship between UXO presence and potential but unused agricultural land.

In contrast, in the provinces of Xayabouly, Vientiane, Luang Namtha, Bokeo and Champasak, the land devoted to agriculture is at least two times the amount of potential land, evincing a high usage of agricultural land, often for commercial purposes. The inclination towards commercial agriculture in these regions could be due to a combination of adequate geographic, infrastructural and institutional features. Almost all of the provinces mentioned above have large areas of lowland plains in proximity to the Mekong River and its tributaries, good road networks, low presence of UXOs, and relatively developed market institutions; these characteristics make these provinces particularly suitable for commercial agricultural activities.



B2 Irrigation facilities

An efficient irrigation system is necessary to ensure that water is available for agricultural development as well as for use by other sectors. Irrigated agriculture plays a vital role in contributing to domestic food security and poverty alleviation. The Lao PDR is better supplied with more freshwater sources than its neighbours in the region. In 2012, the Lao PDR reported a freshwater availability of 53.78 thousand cubic metre per capita, compared with 5 - 33 thousand cubic metres per capita in other countries in the region. The rate of freshwater withdrawal is also one of the lowest in the region, suggesting that the Lao PDR has significant potential for improving its irrigation systems.

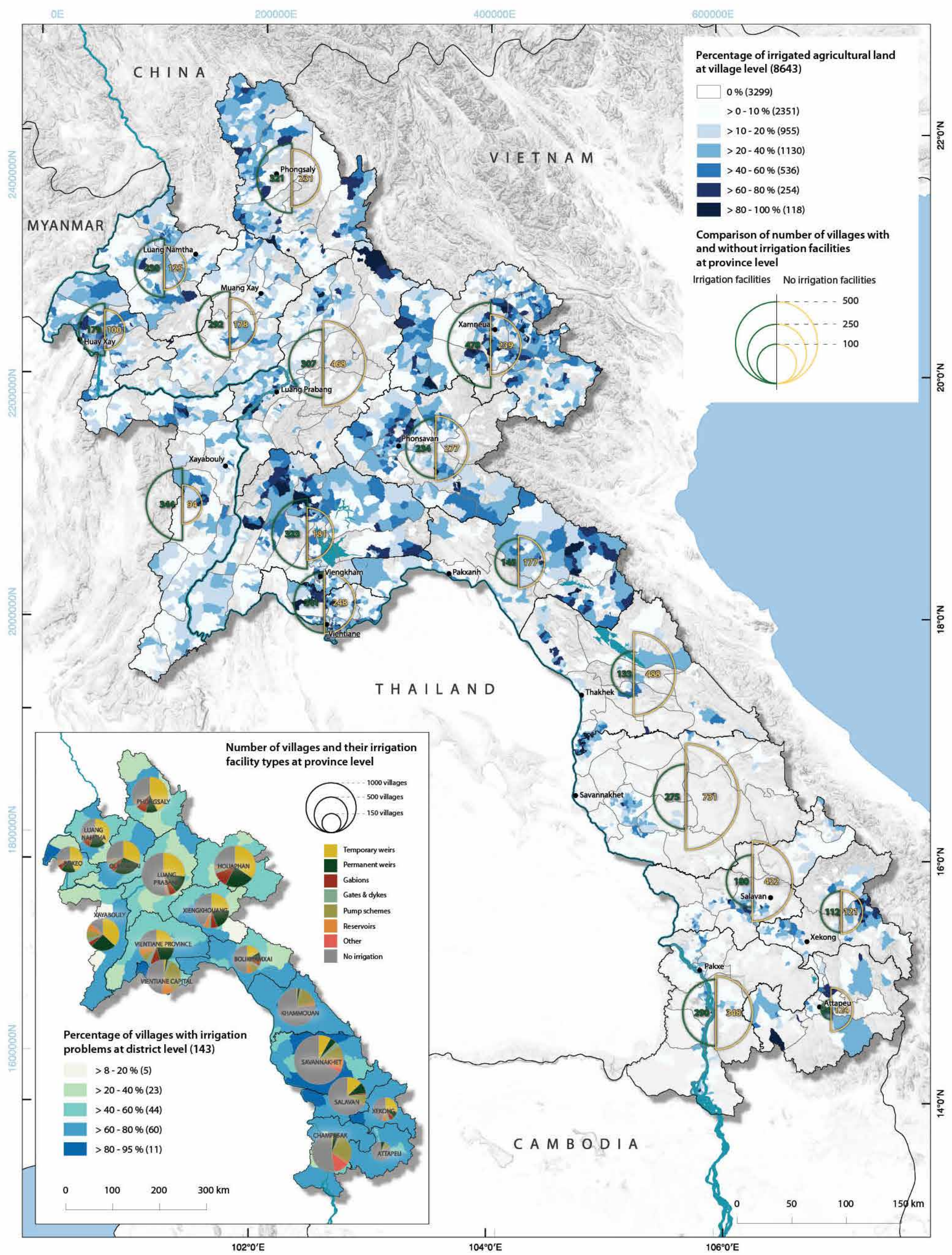
The Government of the Lao PDR made important public investments during the second half of the 1990s to support the installation of 8,000 irrigation pumps along the Mekong River and its tributaries in the plains areas of Vientiane, Savannakhet and Khammouan Provinces. As a result, the country's total irrigated area increased from 0.17 million ha in 1995, to 0.41 million ha in 2011 (Pavelic *et al.*, 2016). In the Lao Agricultural Census 2010/11 farmers were asked whether they used irrigation for their crops during the 2010 wet season and the 2010/11 dry season. The answer was used to estimate the percentage of villages with irrigation facilities.

This map shows the percentage of irrigated agricultural land at the village level. 38 percent of villages do not have any irrigated agricultural land, while more than half of villages reported that between 1 and 40 percent of their agricultural land is irrigated. Most irrigated agricultural land is located in the north and in the centre of the country. In the provinces of Phongsaly, Luang Namtha, Bokeo, Oudomxai, Houaphan, Xayabouly and Vientiane, the majority of villages have irrigation facilities. As the semi-circle diagram shows, 73 percent of villages (344 out of 438) in Xayabouly Province have irrigation systems. By contrast, only 17 percent of villages in Attapeu Province have irrigation systems, 21 percent in Khammouan and 27 percent in Savannakhet.

The irrigation facilities used in the Lao PDR range from permanent weirs to reservoirs, pump schemes, private pump installations, gates and dykes, temporary weirs and gabions. 29 percent of irrigation facilities in the country are temporary weirs. Permanent weirs account for 16 percent of all irrigation facilities in the Lao PDR, while pump schemes, particularly popular in western Champasak, Khammouan, and Vientiane Capital, make up to 8 percent of the total irrigation facilities. Gabions count for 7 percent, while gates and reservoirs count for 3 and 4 percent respectively.

Not all irrigation facilities are in consistent functioning order. The map highlights how villages in central and southern Lao PDR are more exposed to irrigation problems. The main irrigation problems that farmers face are not only related to the lack of irrigation facilities, but are also linked to high water fees and maintenance costs of the irrigation schemes. In Savannakhet Province a particularly high percentage (80 - 95 percent) of villages experience irrigation problems across several districts.

Despite the country's wealth in freshwater resources and rainfall, the irrigation systems in the Lao PDR remains limited and, in some areas, inefficient.



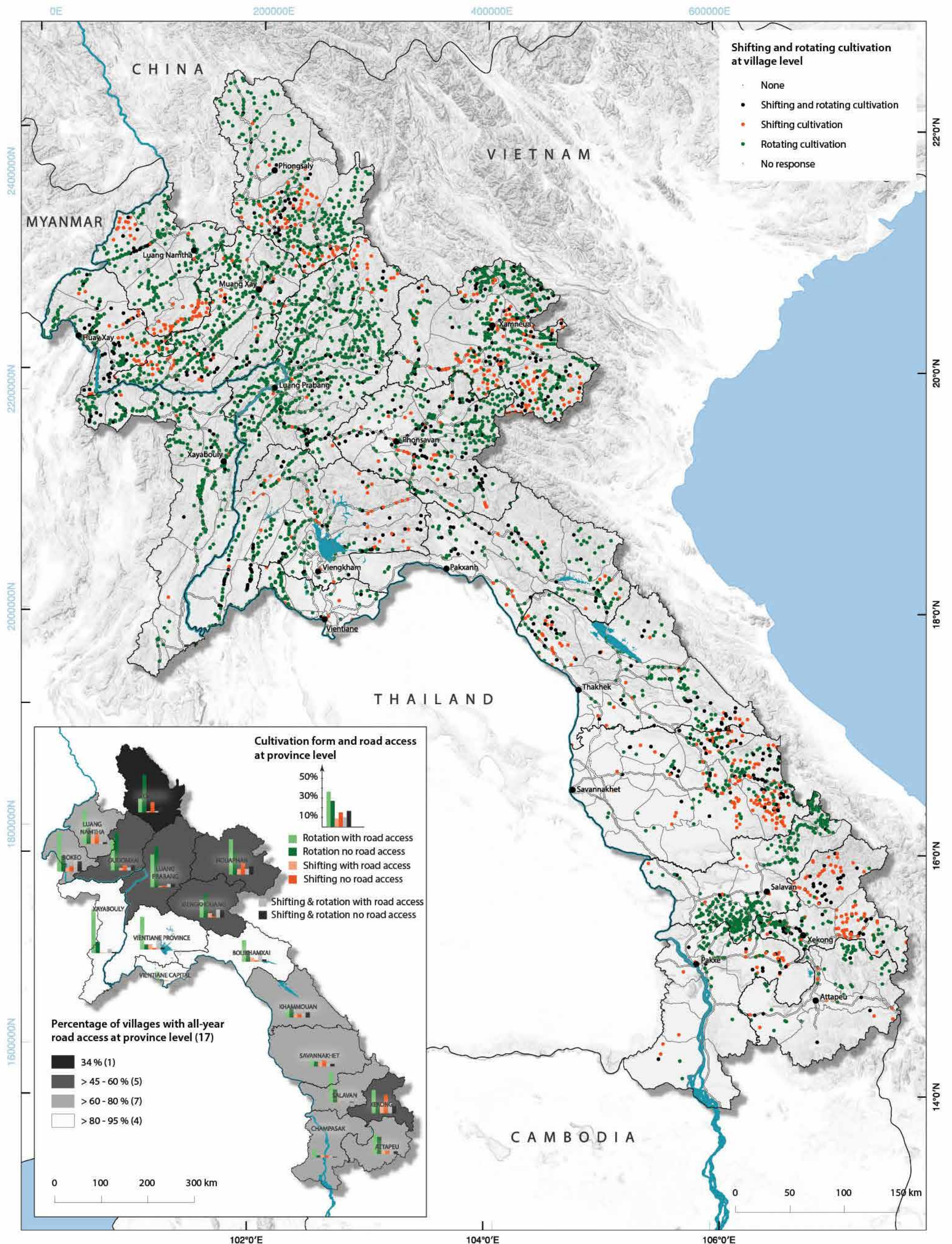
B3 Shifting and rotating cultivation

Shifting cultivation refers to a farming practice also known as “swidden” or sometimes “slash-and-burn agriculture”. It is a crop growing method under which farmers clear a plot of land by cutting down trees and shrubbery before burning it. Usually, the land is left fallow after harvesting for a period long enough to allow the vegetation to recover. Once recovered, the land can be cleared and used again to grow mostly rice crops. Although practiced for centuries, especially in Southeast Asia, there is a wide, open debate around the sustainability of shifting cultivation. The GoL regards shifting cultivation as a primitive production form, associated characterized by low output productivity, inefficient use of land and human resources, and deforestation. As a result, at the 1989 National Forestry Conference, the Lao Government sought to reduce shifting cultivation and regulate villagers’ agricultural practices in the uplands through forest land allocation. Introduced in the early 1990s, the Land and Forest Allocation Program was meant as a mechanism to stabilize and eventually eradicate shifting cultivation (Fujita and Phanvilay, 2008). More recently, the GoL has promoted rotational shifting cultivation involving a three-plot approach with shorter fallow periods. The sustainability of this approach is highly debated.

This map displays villages engaged in shifting cultivation, rotating cultivation, or both. The dots on the map show that shifting and rotating cultivation practices are implemented throughout the country, with high concentrations in the upland villages of the northern provinces and in the mountainous areas along the Vietnamese border. Geographical location and monitoring by local government authorities both substantially influence the type of agricultural practice adopted.

Located in the north of the country, Phongsaly Province has a high number of villages engaged in shifting cultivation. Phongsaly is also the least accessible province in the country; as can be seen from the smaller map of village road accessibility, only 34 percent of its villages have full-year road access. There is therefore an observable negative correlation between villages engaged in shifting cultivation and road accessibility. In the south, Xekong Province also has a low percentage of villages with all-year road access, and meanwhile, numerous villages practice shifting cultivation. Shifting cultivation is also widely practiced in the provinces of Luang Namtha in the northwest and Houaphan in the northeast. Farmers in Phongsaly, Oudomxai, Luang Prabang, Xiengkhouang and Khammouan favour rotating cultivation systems over shifting cultivation practices; this cultivation practice is sometimes disproportionately associated with certain ethnic groups dominant in these provinces.

B3 Shifting and rotating cultivation



B4 Agricultural population

Agriculture is the main economic activity for the Lao population. It employs an estimated 75 percent of the total workforce, and contributes to 25.5 percent of GDP (FAO, 2010). Female farmers are responsible for over half of all agricultural activities.

Agricultural households are defined as households operating 200 m² or more of agricultural land either in the wet season or dry season. The average agricultural household size is 5.7 people, with a sex ratio (number of men per 100 women) of 101.1 at the national level. The majority of households (65 percent) have landholdings between 0.5 and 2.99 ha. Close to 27 percent have landholdings of 3 ha and above, and they account for 58 percent of the total farmland in the country. Agricultural households with large landholdings tend to have a larger household size.

This map shows the share of agricultural households at village level. The darker shades of green indicate a higher percentage of agricultural households in the village. In the north, the northeast and the southeast, there is a particularly high percentage of agricultural households, while urban and peri-urban areas have a lower proportion. In more than 34 percent of all villages (2,956 villages), the share of agricultural households exceeds 99 percent, while in 67.7 percent of the villages (5,851 villages) the share of agricultural households exceeds 90 percent. These statistics reflect the importance of agriculture in the country. Table 1 gives detailed information about the total number of households, the total number of agricultural households and the share of agricultural households in 1999 and 2011 per province.

The province level inset map shows that between 90 and 96 percent of the households in Xayabouly, Oudomxai, Phongsaly and Houaphan are engaged in agricultural activities. In the provinces of Bokeo, Luang Namtha, Salavan, Xekong and Attapeu, between 80 and 90 percent of households are engaged in agriculture. In Vientiane Capital, the most urbanized area in Laos, only 32 percent of households are still considered agricultural households. The ratio in the other provinces ranges between 55 and 80 percent.

With 79 percent of its households (108,600 households) in agriculture, Savannakhet Province (137,300 households) has the highest absolute number of agricultural households. By contrast, Xekong has only 12,900 agricultural households. In Phongsaly, out of the total 29,200 households, 28,100 (96 percent) are agricultural households, making the province the most reliant on agriculture in the country.

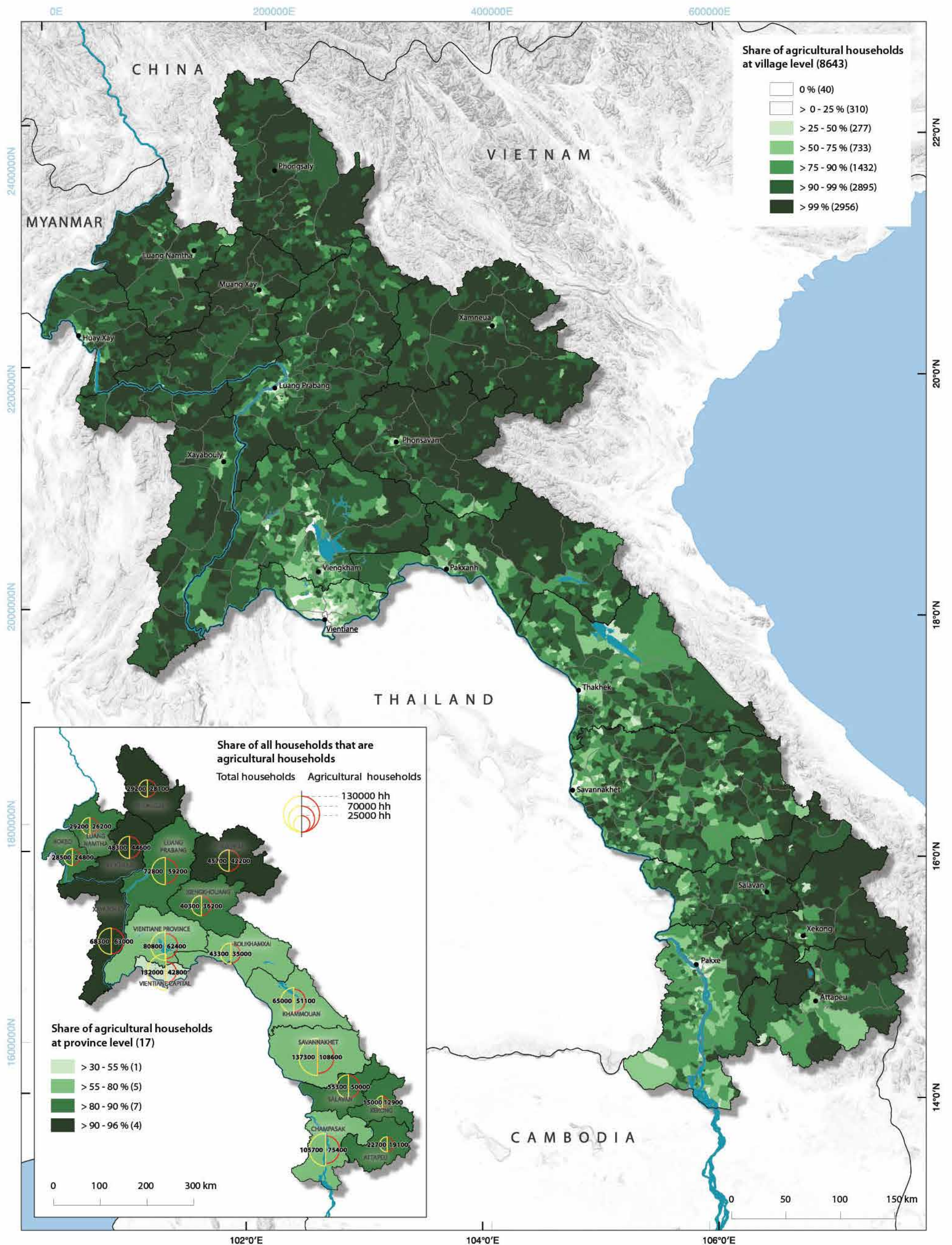
Interestingly, as can be seen in Table 1, the proportion of agricultural households between 1999 and 2011 decreased in all provinces except Phongsaly, where it increased slightly. In Vientiane Capital, the percentage of agricultural households declined significantly from 50.1 to 32.1 percent, this is mainly due to the rapid urban expansion experienced by the capital in the last decade.

At least one agricultural household is present in every village in the Lao PDR, with the exception of forty villages. These villages are located within urban areas as well as on the shores of lakes and reservoirs, where households rely on fisheries or aquaculture for their livelihoods.

Table 1: Total number of households and agricultural households and share of agricultural households in total households in 1999 and 2011

Province	No. of households 1999	No. of households 2011	No. of agricultural households 1999	No. of agricultural households 2011	Share of agricultural households 1999	Share of agricultural households 2011
Vientiane Capital	97,000	132,000	48,600	42,800	50.1	32.4
Phongsaly	25,600	29,200	24,400	28,100	95.3	96.2
Luang Namtha	21,400	29,200	19,800	26,200	92.5	89.7
Oudomxai	35,800	48,300	33,400	44,600	93.3	92.3
Bokeo	20,800	28,500	18,800	24,800	90.4	87.0
Luang Prabang	62,000	72,800	55,700	59,200	89.8	81.3
Houaphan	38,500	45,700	36,900	42,200	95.8	92.3
Xayabouly	52,300	68,300	49,400	63,000	94.5	92.2
Xiengkhouang	30,900	40,300	28,100	36,200	90.9	89.8
Vientiane	50,200	80,800	43,700	62,400	87.1	77.2
Bolikhamxai	29,600	43,300	26,500	35,000	89.5	80.8
Khammouan	52,400	65,000	43,600	51,100	83.2	78.6
Savannakhet	111,800	137,300	95,400	108,600	85.3	79.1
Salavan	45,400	55,300	41,300	50,000	91.0	90.4
Xekong	10,500	15,000	9,700	12,900	92.4	86.0
Champasak	89,400	105,700	70,200	75,400	78.5	71.3
Attapeu	16,400	22,700	14,800	19,100	90.2	84.1
Total	790,000	1,019,400	660,300	781,600	83.6	76.7

B4 Agricultural population



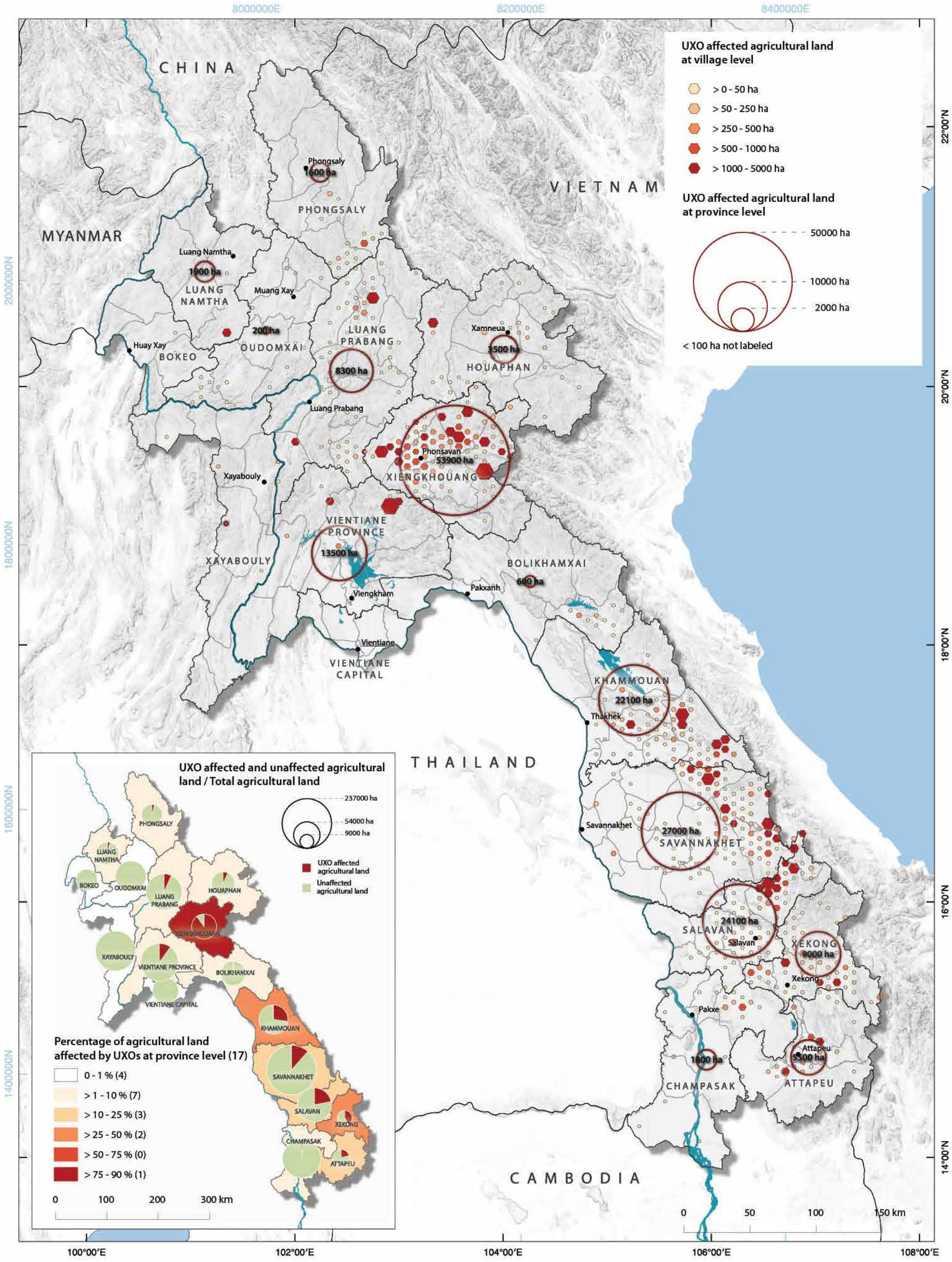
B5 Agricultural area affected by UXO

Per capita, the Lao PDR is the most heavily bombed country in the world. Although all 17 provinces of the Lao PDR are affected by Unexploded Ordnances (UXOs), the most affected areas are located along the Annamite Mountain Range, close to the Vietnamese border. During the 2nd Indochina War (1964 - 1973) more than 2 million tonnes of ordnance were dropped across the country as part of the United States' Secret War in the Lao PDR. This war effort aimed to support the Royal Lao Government against the Pathet Lao, and to constrain supply routes along the so-called "Ho Chi Minh Trail" that ran through the Lao PDR, serving as key supply routes for Vietnamese communist insurgents in South Vietnam.

This map shows the area of agricultural land (in ha) affected by UXOs at village, district and province level. The bombings devastated many villages and displaced hundreds of thousands of civilians in the midst of the war. Moreover, it is estimated that of the 270 million cluster munitions dropped, 30 percent malfunctioned and remained unexploded on site. Since then, UXOs have killed, injured, and maimed more than 50,000 people from 1964 to 2008. Today, UXOs continue maiming and killing people, while hindering socioeconomic development and food security in affected areas (UXO-NRA, 2014).

Xiengkhouang Province is the most UXO-affected province in both absolute numbers of UXOs dropped and percentage of the total area affected. Today, 53,900 ha of agricultural land (about 90 percent of the province's total agricultural land) are still contaminated by UXOs. Savannakhet and Salavan Provinces follow Xiengkhouang in terms of absolute agricultural area affected, with 27,000 ha and 24,100 ha, respectively. Though smaller in terms of absolute area, the agricultural land affected in Xekong and Khammouan Provinces by UXOs constitutes more than 25 percent of the total.

According to the National Social-Economic Development Plan (UXO Lao, 2013) there is a significant correlation between the presence of UXOs and poverty. UXOs limit agricultural production and development in general, from infrastructure construction to tourism development. Today, the Lao government, supported by other governments and international organizations, is trying to eradicate UXOs to make the future brighter in UXO affected areas.



B6 Ratio of market to subsistence oriented households

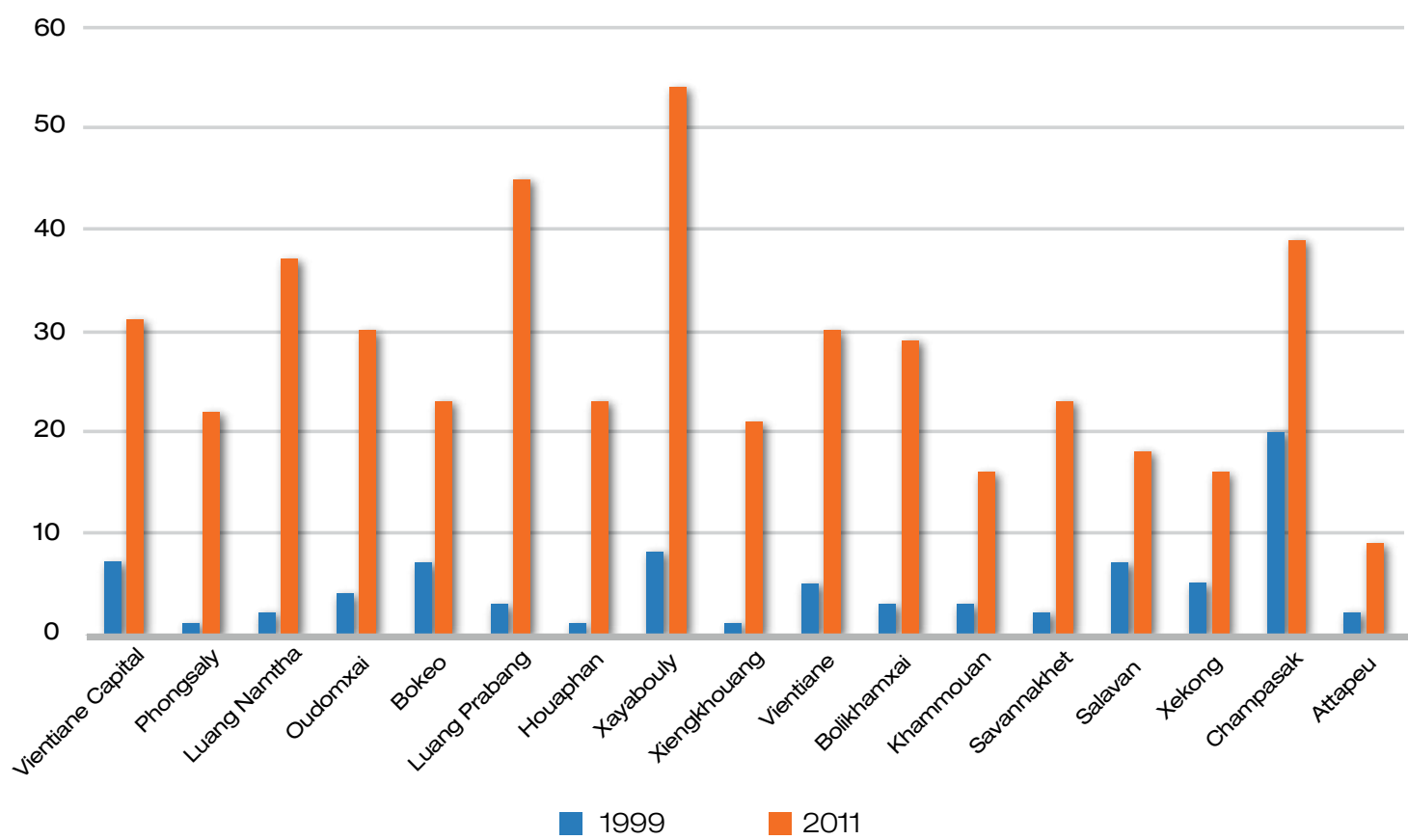
Around 259,000 agricultural households (33 percent of all agricultural households in the Lao PDR) produced mainly for market, compared to only 6 percent of agricultural households in 1998/99 (ACO, 2012). The main crop produced is rice, which accounts for 70 percent of the total cultivated area. Other important crops include maize, coffee, sugarcane, cassava, banana and industrial tree crops (such as rubber, eucalyptus and acacia).

This map illustrates the percentage of market-oriented and subsistence-oriented agricultural households at village level. The areas in the south of Xayabouly and on the Bolaven Plateau in the east of Champasak have a stronger market-orientation. As highlighted by the inset map on the bottom left, Xayabouly is the only province in the Lao PDR where more than half of agricultural households are market-oriented in their production systems, wherein maize predominates, followed by cotton, peanuts, Job's tears, and cowpeas. The Bolaven Plateau is mainly focused on coffee production and secondarily on cardamom. Other important areas for market-oriented agriculture are found in southern Luang Prabang, in western Phongsaly and central Oudomxai. In these three provinces, more than 25 percent of all agricultural households are commercial producers.

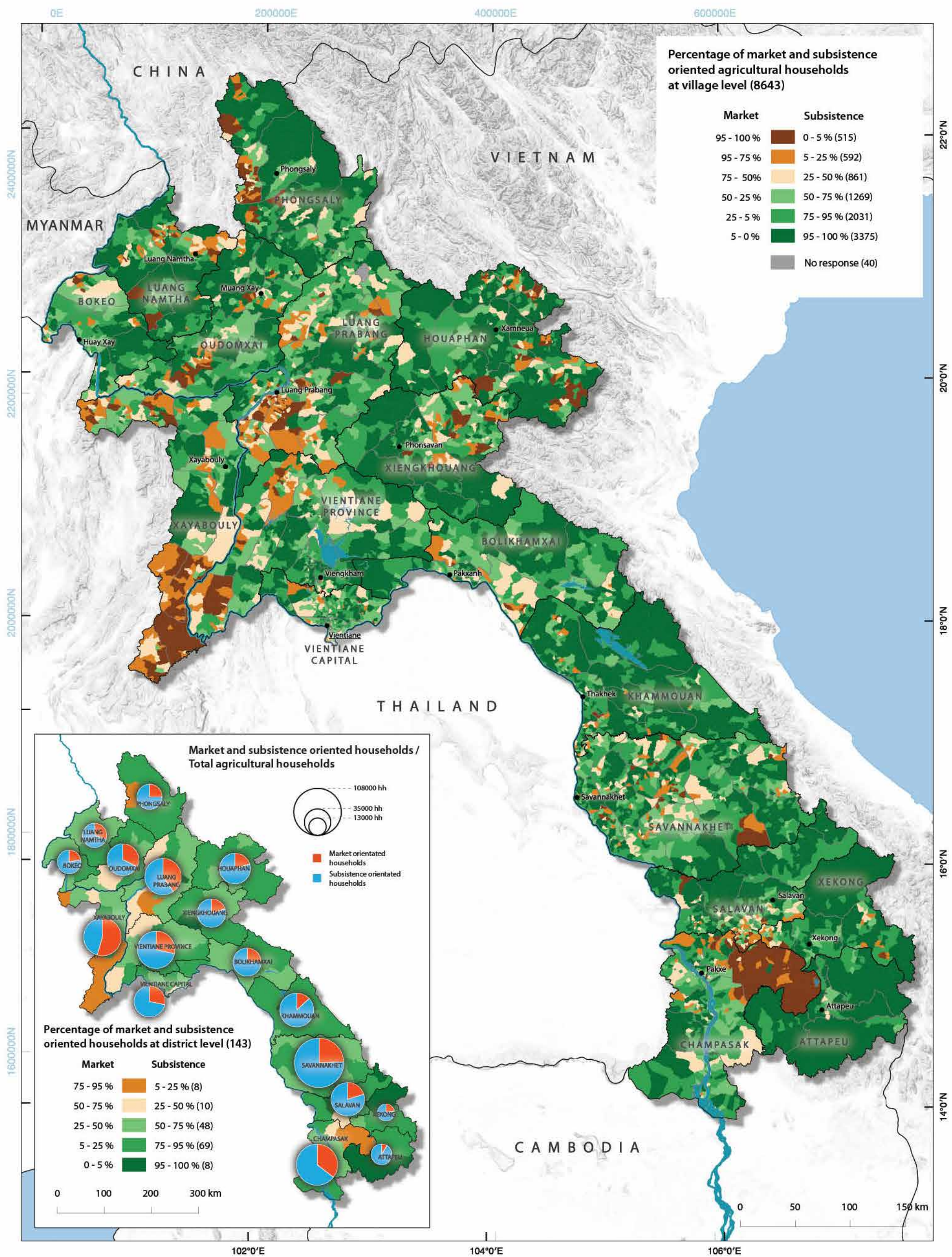
As shown by the largest pie chart on the small map, Savannakhet Province has the highest number of agricultural households, more than 75 percent of which are subsistence producers. In Attapeu Province, more than 85 percent of agricultural households are subsistence-oriented, making Attapeu the least market-oriented province in the Lao PDR. In Khammouan, more than 80 percent of agricultural households are subsistence farmers. Figure 1 gives detailed information about the agricultural production in 1999 and 2011 primarily for market per province.

While the majority of Lao farmers remain subsistence producers, cross-comparison with the 1998/99 census indicates that the Lao PDR is undergoing a major agricultural transition away from subsistence towards more agricultural commercialization.

Figure 1: Percentage of agricultural production primarily for market in 1999 and 2011 per province



B6 Ratio of market to subsistence oriented households



B7 Gender dimensions of wages and heads of households

Aside from performing long hours of domestic work, women take part in many agricultural activities to secure food and income. Although women are major contributors to the agricultural sector, due to the lack of sex-disaggregated statistical data, their contribution often remains invisible and greatly under-evaluated in economic accounts. Gender equality is a key priority of the GoL, which seeks to promote gender equality between men and women in all sectors. It is a core development objective within the commitment to improve people's livelihoods and living standards (ADB and the World Bank, 2012).

In the agricultural sector, gender concerns were integrated into specific programs and projects through a number of measures. MAF has recently developed a policy for the advancement of women in agriculture and forestry, which is based on six goals. Two of the main goals are the integration of gender analysis and gender-disaggregated data, information, and statistics into the MAF planning cycle, and the increase in rural women's access to and control over resources and benefits.

In the 2010/11 Agricultural Census, village heads were asked to compare the wages of agricultural labour for women with the cost of agricultural labour for men. In 29 percent of villages, the village head did not respond to the question, whereas in 67 percent of the villages wages were reported as being the same, in 3 percent women were reported to earn more than men, and in 1 percent of villages men were reported to earn more than women.

The province level histograms compare the percentages of villages in which men earn more than women, and vice versa. In Bokeo, for instance, men's wages are higher than women's wages in 2.5 percent of the villages. Meanwhile, in the same province, women's wages are higher than men's in 2.1 percent of the villages. Oudomxai and Luang Prabang present the same trend. In contrast, in central Lao PDR, women's agricultural wages are higher than men's, while the southern provinces do not present any visible pattern.

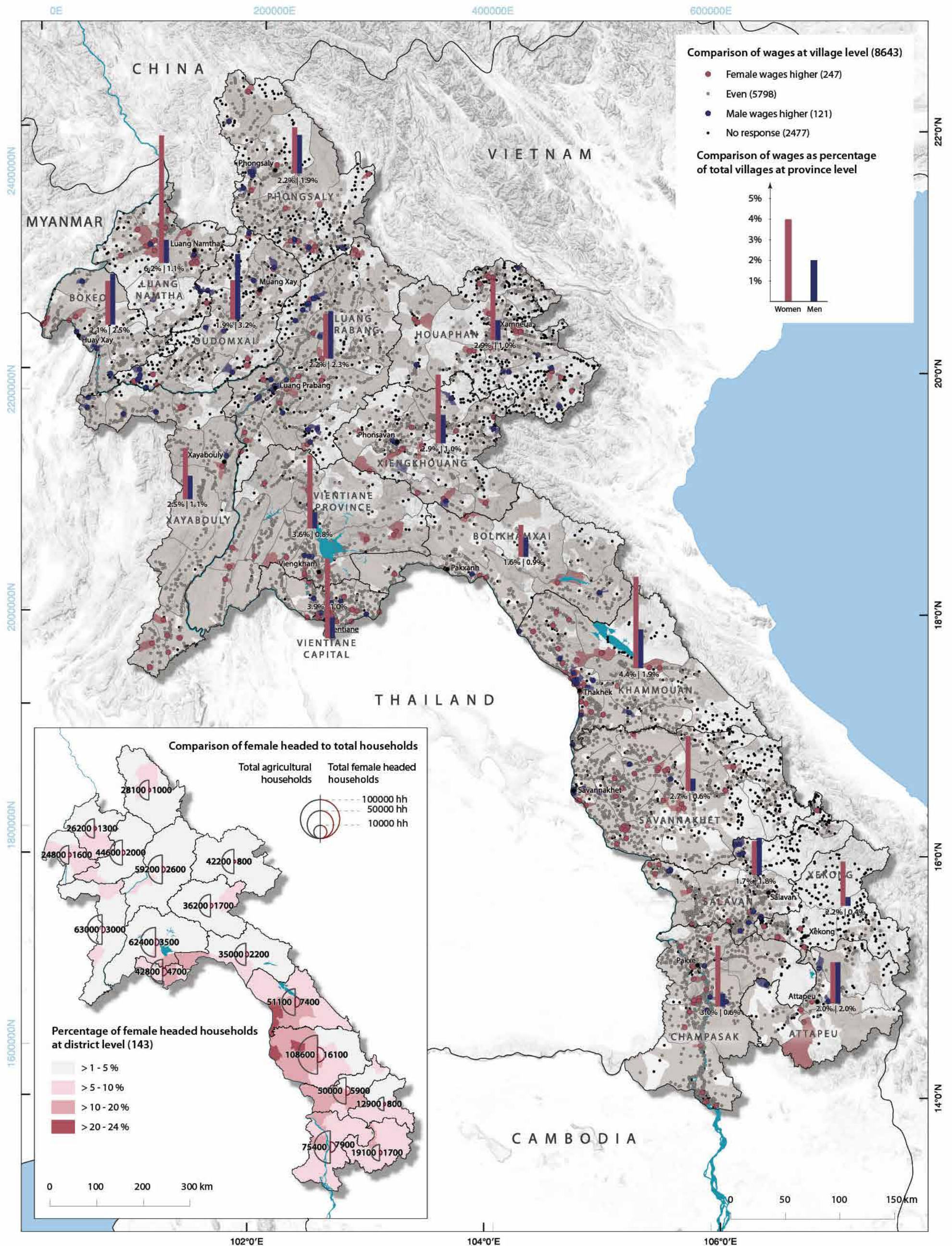
In Luang Namtha women's agricultural wages are higher than men's agricultural wages in 6.2 percent of the villages. Khammouan Province and Vientiane Capital follow the same trend with women's agricultural wages are higher than men's in 4.4 and 3.9 percent of villages respectively.

In contrast, 3.2 percent of villages in Oudomxai Province reported that men's agricultural wages are higher than women's agricultural wages. Bokeo and Luang Prabang Provinces present the same pattern with percentages of 2.5 and 2.3 respectively.

The map at the bottom left shows the proportion of female headed households at province and district level. 90 percent of farm households are male-headed, while only 8 percent are female-headed. 55 percent of the female-headed households are located in the central provinces, while the southern and northern provinces share respectively 25 percent and 19 percent. The percentage of female-headed households per province is the highest in Savannakhet (15 percent), in Khammouan (14 percent) and in Salavan (12 percent). The maps show how women's agricultural wages tend to be higher than men's in central Lao PDR than in the north and the south; this could be due to economic development in these areas that has led to more opportunities for women. While considering this trend, it is important to keep in mind that 29 percent of villages did not respond to the survey question, and in 67 percent of villages the majority of households reported that agricultural wages of men and women were equal.

Traditionally, the husband is recorded as the head of the household in the Lao PDR, which explains the rather low number of female-headed households. Most female heads of household are widows, while some are divorced and/or one spouse has migrated to cities or abroad, which influences the households structure. Population movement might therefore be a reason that the highest share of female-headed households are found in central Lao PDR where migration to Thailand is most prominent.

B7 Gender dimensions of wages and heads of households



B8 Source of agricultural income

The majority of the Lao population lives in rural areas and engages in a diversity of subsistence and income generating activities. Their livelihoods rely heavily on natural farming systems and forest-based resources. External as well as internal factors influence the kinds of livelihood activities performed, including: government policy, geographic location, ethnicity, access to markets, knowledge, and technology, among other factors.

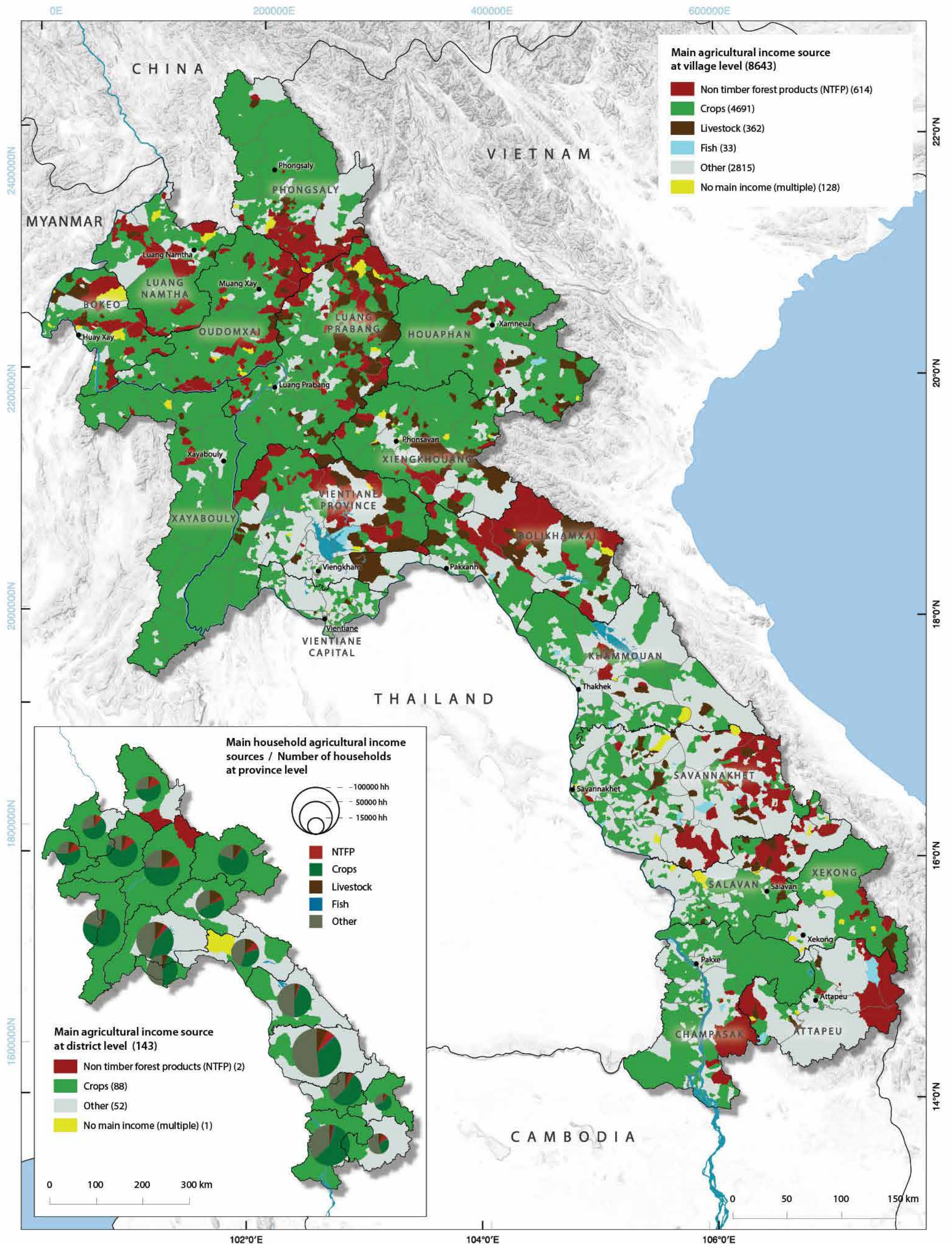
The main income sources at village level are divided into four main categories: non-timber forest products (NTFPs), crops, livestock, and fish. The map shows that crop production is the main agricultural income source in 54 percent of the total villages, especially in the northern provinces. Although 49 percent of all farm households collect fruits and vegetables from the forest, and 55 percent collect mushrooms, only 614 villages rely primarily on NTFPs for household income. Village level collectors sell NTFPs at local markets as well as to traders. Livestock activities in the Lao PDR are mainly for household consumption; only 4 percent of the villages in the country classify livestock as the main agricultural income source. Cattle, buffaloes, pigs, and poultry are the main types of livestock raised. Fishing is also a vital activity for many farm households in the country. It is the main income-generating activity of 68,200 farm households nationally. Although less common than fishing, aquaculture is the main source of income for about 1,000 households in the whole country. In this map, fishing and aquaculture are merged together and are reported as main source of agricultural income in 33 villages through the whole country.

Crop production is the main income activity for most of the villages in the north and for the majority of the villages in the southern provinces of Salavan, Xekong and Champasak. As shown by the smaller inset map, households in Xayabouly earn more than 75 percent of their total income from crop production. Household income in Attapeu,

Savannakhet, Khammouan and Vientiane Capital is generated primarily from a range of activities that fall outside of collecting NTFPs, cultivating crops and livestock, or fishing. The map illustrates how the villages that reported NTFP collecting as their principal income source are mainly located in mountainous areas and in the centre and north of the country, as well as in eastern Attapeu and southeastern Champasak. The inset map shows how NTFPs are the main agricultural income source in the most southern district of Phongsaly Province, Khua District and in the northernmost district of Luang Prabang Province, Phonthong District. Bolikhan District, in western Bolikhamxai, presents a particularly high degree of diversification in its income generating activities.

In summary, crop production is the main source of income for farmers in 88 districts, while 52 districts, mostly located in the centre of the country, have other main income sources not explicitly listed during data collection. NTFPs are the main income source in two districts in total. Remarkably, in one district in Bolikhamxai (Bolikhan) the majority of the households reported no single main income source but instead cited multiple income generating activities as equally important.

As mentioned above, different factors influence agricultural income sources. More specifically, regional market dynamics, from traditional cross-border trade with neighbouring countries to market-oriented policies implemented more recently by the GoL, are principal drivers in the transition toward market-oriented agriculture. In addition to regional market dynamics, recent economic developments in neighbouring countries also affect household livelihoods and farming systems in the Lao PDR. The main impact has been a widespread shift in the orientation of agricultural production activities from subsistence to commercial production, especially in northern Lao PDR (see B6).



B9 Natural disasters: Flood, drought and landslides

The climate of the Lao PDR is tropical and divided into a wet and a dry season. The wet season occurs from May to October. The Lao PDR is also affected by tropical storms coming often from the South China Sea and cyclones. Flooding occurs along the Mekong River and its tributaries, but is of a sporadic nature and with a typical duration of several days. Landslides induced by heavy rainfall occur frequently in steep upland areas and often accompany tributary flooding. On average, severe floods occur every fifth year and severe drought occurs every second year. However, in recent years, the occurrence of flooding and drought has increased.

The map shows the types of natural disasters occurring in the Lao PDR at the village level. Drought occurs throughout the country, but most drought events occur in western Champasak, Salavan and Savannakhet, and in the northeastern part of the country in Xiengkhouang, Houaphan and Luang Prabang Provinces. Floods occur less frequently than droughts but remain common along the Mekong River flood plains and its main tributaries throughout the country. In central and southern Lao PDR, especially in Khammouan, Savannakhet and Attapeu, and in the south of Xayabouly and Bokeo, drought and flood often occur in the same year.

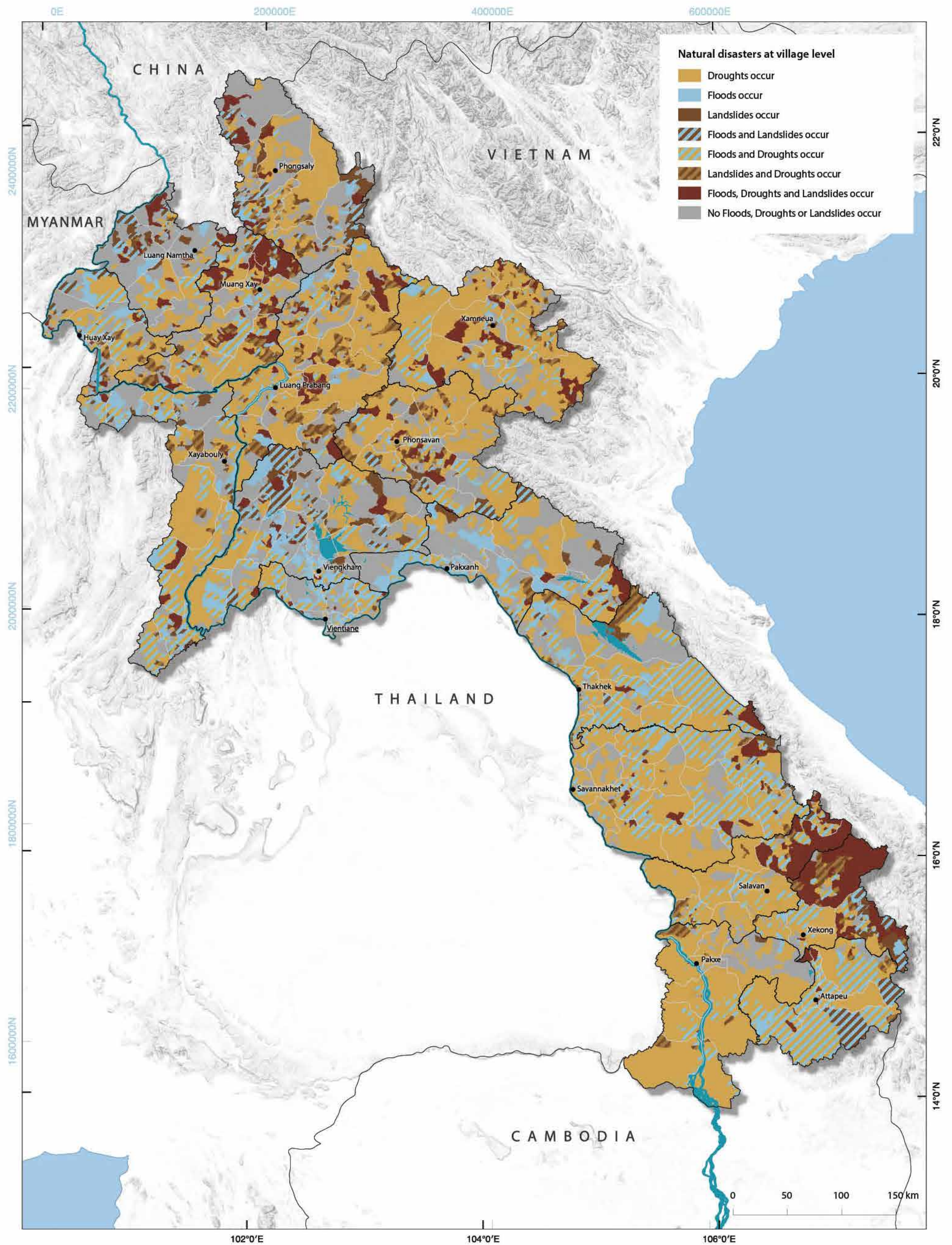
In addition to drought and flood, landslides occur in the mountainous areas of northern and southern Lao PDR. Some villages even experience all three - flood, drought, and landslides - mainly in the eastern mountainous areas of Salavan and Xekong Provinces. Villages where all three disasters have been reported are also found in the mountains of northern Lao PDR, especially northern Oudomxai Province. Central Lao PDR is less prone to natural disasters than the southern and northeastern parts of the country.

This map shows the 2011 status of the disasters and gives a broad understanding of the spatial distribution of different types of disaster occurrences, as reported. Natural disasters have significant impacts on livelihoods, especially in rural areas where subsistence agriculture remains predominant.

Rain-fed rice cultivation constitutes more than 90 percent of the rice growing area in the country, whereas only about 6 percent of rice growing areas have access to irrigation facilities. Drought occurrence therefore has a significant impact on the total annual rice production of smallholder farmers. According to Schiller *et al.* (2006), drought and flood regularly destroy rice harvests. Drought, as the map shows, can affect larger areas than flooding, as floods are more localized and concentrated in their destruction. Drought is known to occur at two times of the year: the early monsoon season and the late monsoon season. In the latter season, drought can take the greatest toll on cultivation. Flash floods tend to occur more frequently in areas with a high degree of damaged forest coverage and/or heavy land exploitation.

The impacts of natural disasters vary across the Lao PDR. Vulnerability to natural disasters is influenced by many factors such as access, institutional preparedness, early warning systems, etc. Often the most remote areas are the most highly-affected economically and socially by natural disasters. This is particularly true in the case of eastern Xekong and Salavan, which are prone to the three main natural disasters and are also among the poorest areas of the country. Current information lacks the necessary precision and accuracy to ensure evidence-informed planning and decision-making. Data collection and sharing should therefore be improved in the future to build a better strategy for disaster management.

B9 Natural disasters: Flood, drought and landslides



B10 Credit facility and selling agricultural produce

Although interest rates in the informal sector can be as high as 20 percent per year, interest rates for agricultural households for farming operations remains limited to 13 percent in the Lao PDR. However, different credit facilities are available to farmers including public banks, foreign banks, private domestic banks, microfinance institutions, and village development funds. In terms of agricultural marketing facilities, farmers sell their produce through various channels: direct sale in the village local market, buy-back arrangements through contract farming, direct sales to processing companies, and selling through intermediaries or brokers in the same village or nearby villages.

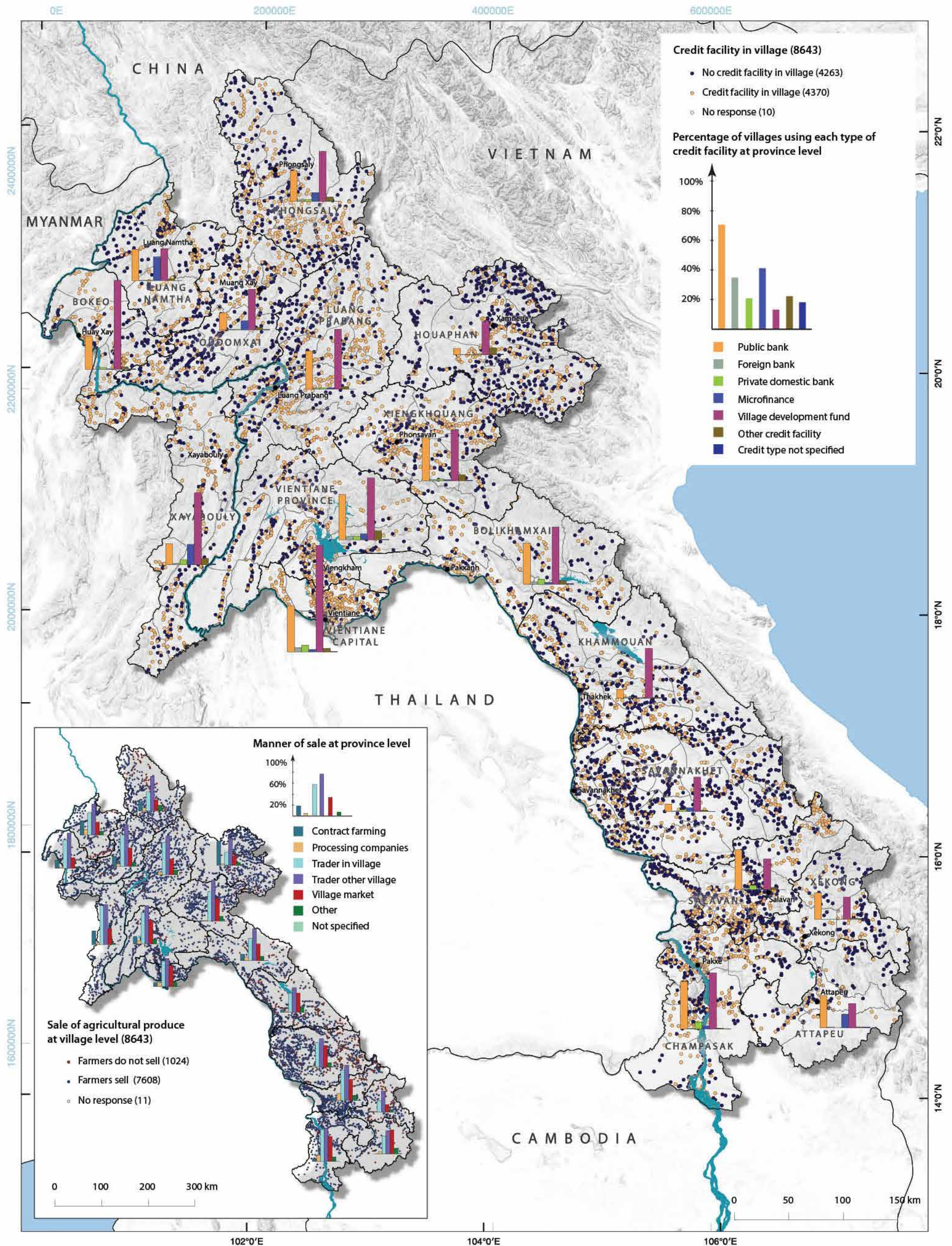
Overall, 51 percent of all villages have access to credit facilities as can be seen on the main map. Villages with credit access are sparsely distributed throughout the country, with a higher density in the northern provinces of Oudomxai, Luang Prabang and Xiengkhouang, and the southern province of Champasak. These villages are more likely to be located in areas with good road connectivity. Vientiane Capital is the most credit accessible, with 82 percent of its villages able to access credit. The provinces of Bokeo and Xayabouly follow, with 60 percent each. Houaphan and Savannakhet on the contrary, are the two provinces with the lowest percentage of villages with credit access, with only 28 percent and 27 percent of villages respectively. Village development funds are the main credit source, adopted by a large proportion of the villages in each province, particularly Vientiane Capital, Xayabouly, Bokeo, Houaphan, Khammouan and Savannakhet. Public banks are another key source of credit reported by a high proportion of the villages in almost all provinces. Microfinance is also important, especially for villages located in Luang Namtha, Xayabouly and Attapeu.

The inset map at the bottom left shows in which villages farmers engage in market transactions, as well as province level trends indicating in which channels they sell their produce. In approximately 88 percent of all villages in the Lao PDR, farmers sell part of their agricultural produce, whereas the remaining 12 percent produce exclusively for their own consumption or for exchange for other goods. As is shown in the province-level graphs, selling to traders from other villages is the most common way to market produce, followed by selling to traders from the same village. Selling via contract farming schemes, directly to processors, and at village markets are less common channels nationally, but are predominant in the north, especially in Houaphan, where more than half of all villages engage in contract farming.

While about half of the total villages have credit facilities, not everyone has access to credit. A GIZ survey on semi-formal and formal providers of microfinance in the Lao PDR indicates that access to formal financial services is extremely limited for the rural poor. This remains one of the biggest challenges even though there has been significant progress in recent years. The utilisation of different channels for marketing agricultural produce, such as contract farming or direct sales to processing companies, reflects the degree of agricultural commercialisation. The emergence of contract farming throughout the northern provinces, especially Houaphan, Luang Namtha, Xayabouly, Oudomxai and Bokeo, is mainly a result of the trade relations between these provinces and neighbouring countries with strong market demand – China, Thailand and Vietnam.

Road connectivity is another important factor for both access to credit and market institution development. Roads reduce the costs of transport and make trade more convenient, thus increasing market connections as well as the capacity of households to add value to the land and housing, which are the main assets used as forms of collateral for credit.

B10 Credit facility and selling agricultural produce



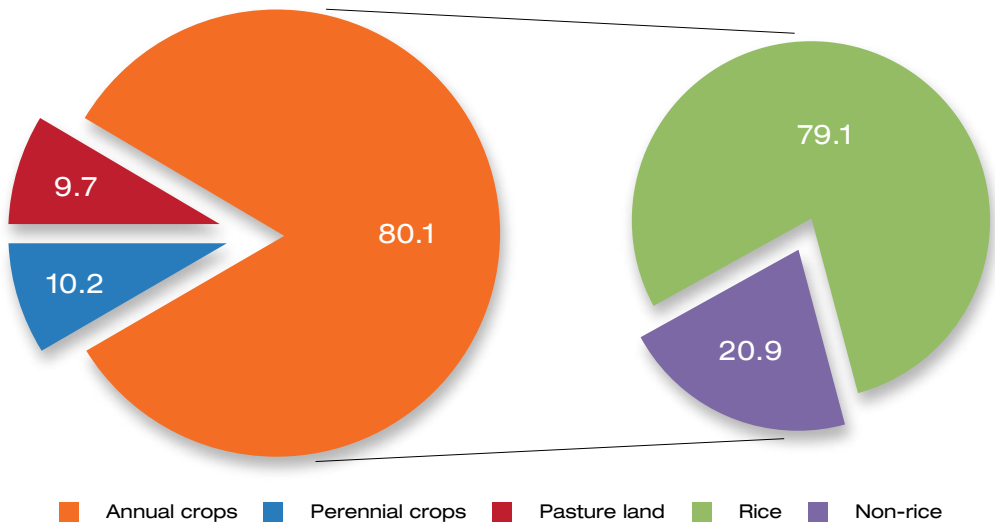
CROPS

C1 Ratio of perennial to annual wet season crops

Introduction

In total, 1.19 million ha or 80 percent of all agricultural land in the Lao PDR (1.49 million ha) is used for planting annual crops. Of this, 0.94 million ha (79 percent) is under rice cultivation. Another 0.15 million ha (10 percent) of agricultural land is devoted to cultivating perennial crops and the remaining 10 percent or 0.14 million ha is used as permanent pasture. Figure 2 shows the area under perennial crops, annual crops and pasture land as percent of total agricultural land.

Figure 2: Percentage of area under perennial crops, annual crops and pasture land



Most annual crops grown in the Lao PDR are grown at small scales and predominantly for household consumption; however, an increasing number of annual crops such as cassava, maize, sweet corn and sugarcane, are grown at larger scales to supply growing international market demand and also domestic agro-processing factories. In contrast, perennial crops planted are often associated with large capital investment and normally invested in by wealthy farm households with sufficient land and capital or by foreign investors. Supported by national and international development policies and programs, there has been increasing cultivation of various perennial crops, including rubber and coffee, for commercial purposes (e.g. through the “Turning land into capital” strategy which encourages land investments).

Patterns in 2011

The two maps display the ratio of perennial to annual crops during the 2010 wet season at three different administrative scales. In most regions, a much higher proportion of land is devoted to annual crops than to perennial crops, but the ratio of perennial to annual crops cultivation in Phongsaly, Luang Namtha, Oudomxai and Bokeo in the north, and also in the south on the Bolaven Plateau, in Champasak, Xekong and Salavan is higher than in the other provinces. Additional information about the total used agricultural area in ha per province is indicated by the size of the circles.

At the district level, more details can be detected. Only 4 of all 143 districts in the Lao PDR have a higher share of perennial crop cultivation than annual crop cultivation, namely Pakxong District on the Bolaven Plateau, Thateng District in Xekong, and Bounneua and Phongsaly Districts in the far north of Laos. In 6 additional districts, which are also located in these two regions, a nearly equal amount of land is devoted to perennial and annual crops.

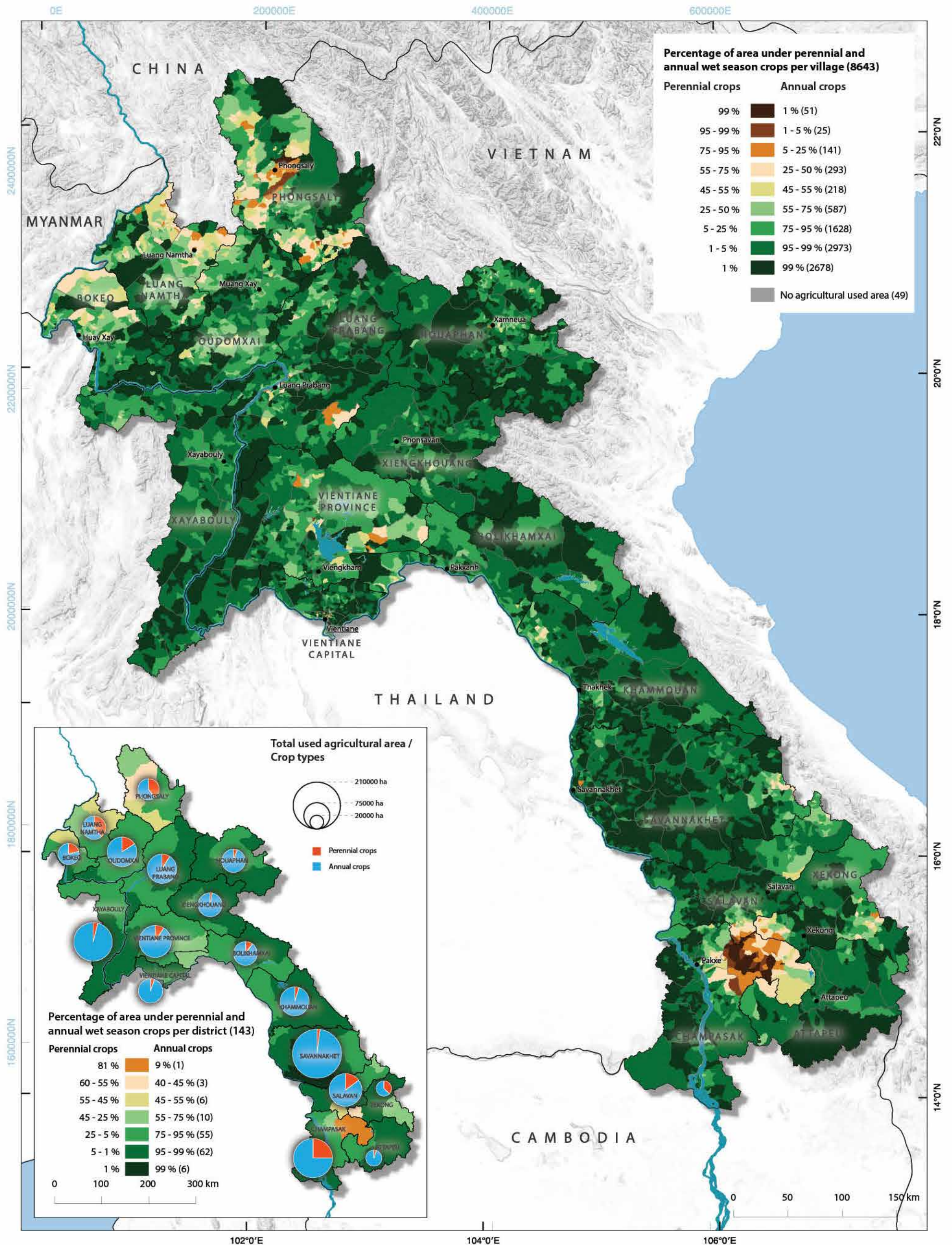
At village level, as shown on the main map, the ratio of area under perennial and annual crop cultivation can be seen at an even more fine scale. In the far north of Laos, the region bordering China stands out. These regions are heavily invested in rubber cultivation in Luang Namtha (see C20) and, to a lesser degree, in cardamom and tea cultivation in Phongsaly (see C23 and C24), hence the high share of area under perennial crops in these regions. Agricultural activities on the Bolaven Plateau centre on extensive coffee production (see C21), but also some cardamom cultivation, hence the high percentage of area under perennial crops there as well.

Interpretations

As smallholders with limited land holdings and cash constraints, the majority of Lao famers opt to cultivate annual crops rather than perennial crops to achieve their livelihood needs and earn immediate income. Perennial crops often require higher capital investment, specialized technical and managerial knowledge, as well as market access to ensure decent financial returns. They also take far longer to produce, which increases risk compared to annual crops.

The demand for perennial crops is on the rise in both domestic and international markets. Drivers of the rise in demand are related to national and international policies, global trade, population growth, and changes in people’s consumption habits. As a result, agricultural households in northern Lao PDR and on the Bolaven Plateau have devoted much of their agricultural land to perennial crop production, in particular to rubber and coffee for which neighbouring country markets have high demand.

C1 Ratio of perennial to annual wet season crops



C2 Area and number of households of annual and perennial crops

Introduction

In the past decade, household cropping systems in the Lao PDR have increasingly diversified such that farmers now grow a large variety of crops aside from rice. From 1999 to 2011, the prices of certain cash crops increased, some stagnated, and some decreased, but there has been an overall increase in engagement in cash crop cultivation.

Across the country, the planting areas of both annual and perennial crops increased significantly from 1999 to 2011. And while a number of perennial cash crops are increasingly cultivated, most land is devoted to annual crop production for both household consumption and for sale. About 95 percent of all farm households in the Lao PDR grow annual crops on about 1.19 million ha, of which 0.94 million ha (or 79 percent) is under rice cultivation. Around 47 percent of all farm households plant perennial crops on a total area of 0.15 million ha.

Patterns in 2011

Map I: Agricultural households cultivate annual crops either during the wet season, the dry season or both. The semi circles on the map show the absolute cultivation area under annual crops during the wet and dry seasons. The area under annual crops nationwide is nearly 1,200,000 ha, of which over 1,100,000 ha was planted during the wet season of 2010 and only about 100,000 ha in the dry season of 2010/11. Roughly 43 percent of all villages in the Lao PDR use more than 95 percent of their agricultural land for annual crops. In Savannakhet, for example, 207,200 ha are used for annual crops during the wet season and 13,200 ha during the dry season.

Map II: As shown on the village-level choropleth map, in 4,858 villages more than 99 percent of all households plant annual crops over two seasons. Only in 125 villages – mainly located on the Bolaven Plateau and in Vientiane Capital – up to 80 percent of all agricultural households grow annual crops over two seasons.

Map III: Meanwhile, perennial crops are grown throughout the Lao PDR, but a few common perennial cash crops (especially rubber and coffee) dominate certain regions of the country. In Champasak, for example, 33,900 ha of perennial crops (mainly coffee) were planted, while 15,900 ha mainly rubber, cardamom and tea are planted in Phongsaly, and 18,500 ha mainly rubber in Luang Namtha.

Most villages reserve only a limited portion of their land for perennial crops. A total of 6,046 villages devote up to 5 percent of their agricultural land to cultivating perennial crops. In contrast, 55 villages, mostly on the Bolaven Plateau and in the north along the Chinese border, use more than 95 percent of their agricultural land for perennial crop cultivation.

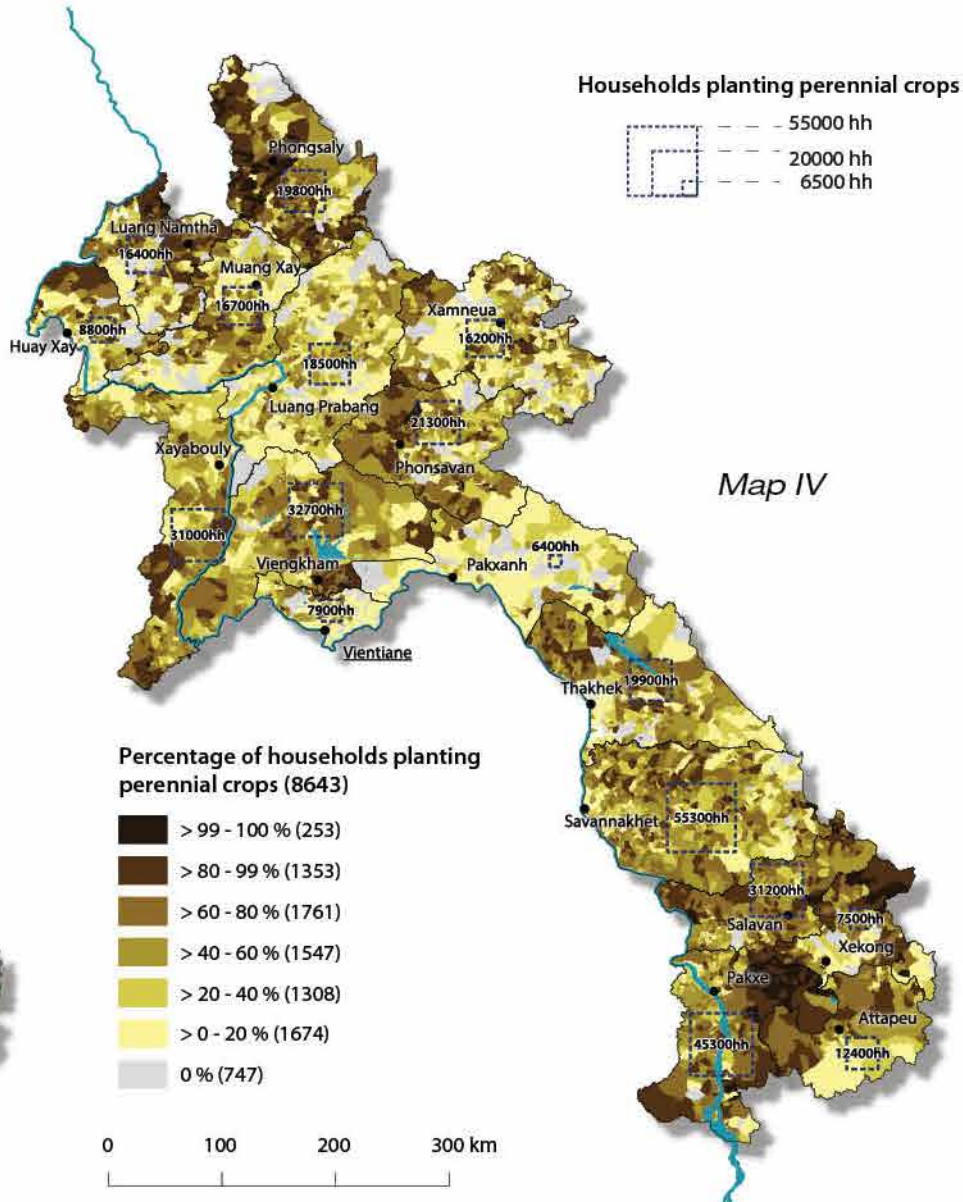
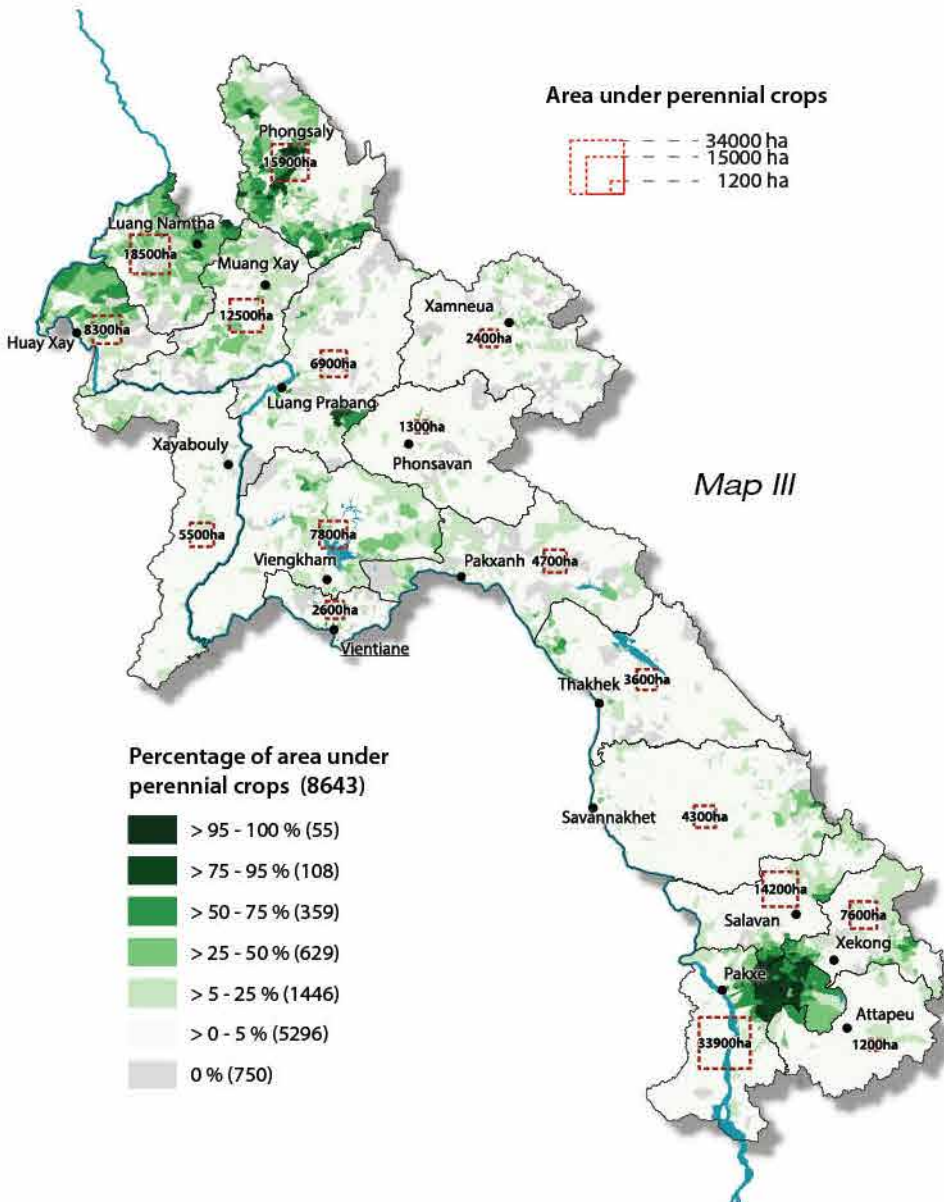
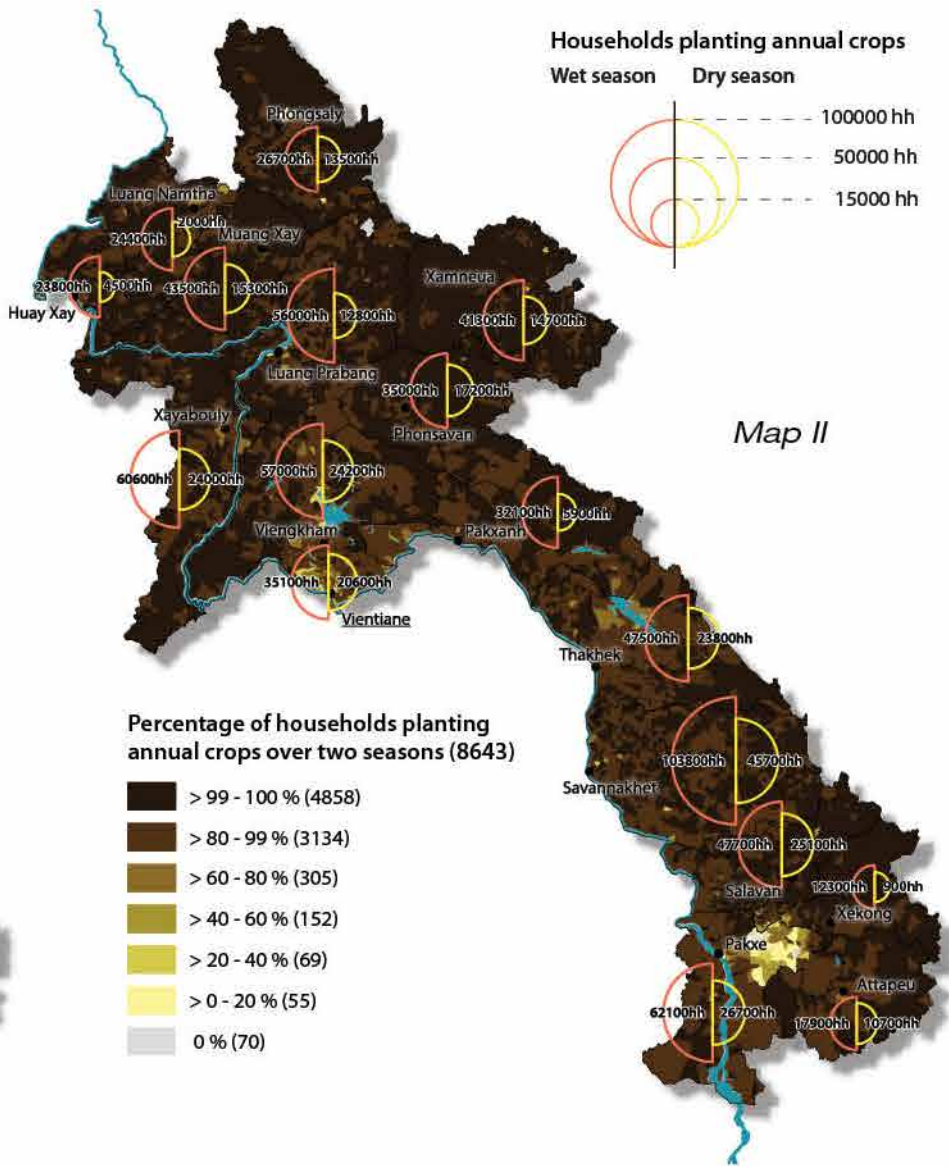
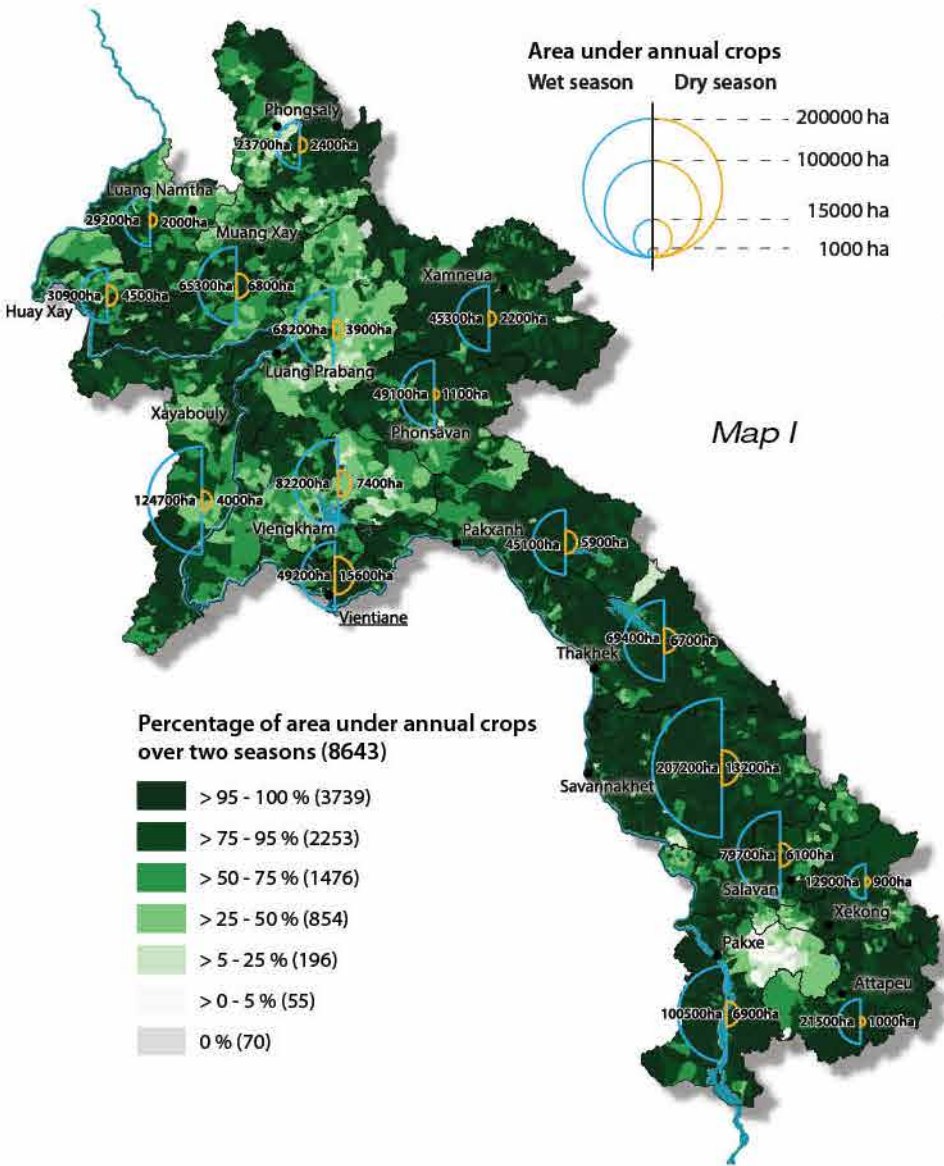
Map IV: Similar patterns are found in terms of the portion of households growing perennial crops. On average, across all provinces about 47 percent of all agricultural households grow perennial crops. In Bolikhamxai, for instance, only 6,400 households cultivate perennial crops, which are only 18 percent of all agricultural households in the province. In Champasak, in contrast, 45,300 households are engaged in perennial crop production, which constitutes 60 percent of all agricultural households in this province.

Interpretations

Annual crops in the Lao PDR are generally grown during the wet season on rain-fed fields, but areas with access to irrigation systems can also be under cultivation during the dry season. The majority of annual crops grown are customarily produced on a limited scale, mostly for household consumption but also for sale. In recent years, however, a number of annual crops (e.g. maize and cassava) are produced at larger scales which serve growing market demand.

The production of perennial crops in the Lao PDR is often done through large-scale capital investment. As such, these crops are more commonly invested in by wealthy farm households with sufficient land and capital resources as well as by foreign investors (mainly Chinese, Vietnamese and Thai companies). However, this dataset contains only information about Lao agricultural households, thus corporate investments and plantations are not included.

C2 Area and number of households of annual and perennial crops



C3 Diversity of crops

Introduction

The Lao PDR has some of the richest agro-biodiversity resources in the world with well over 100 plant and animal species currently under cultivation and between 1,000 - 2,000 species of plants and animals collected for food and other purposes. The country is endowed with very high biodiversity with 8,000 - 11,000 species of flowering plants and one of the greatest gene pools of glutinous rice varieties in Asia, as well as an unknown number of fungal species. Lao farmers grow various annual and perennial crops in response to growing connections to domestic and global markets. The 2010/11 Agricultural Census indicates a total of over 100 different kinds of annual crops and over 80 different kinds of perennial crops reported under cultivation in the Lao PDR. The main annual crops are rice, fodder crops (mainly maize), sweet corn, cassava, chilli, Job's tear, cabbage, soybean, sesame, cucumber and pumpkin, sugarcane, tobacco, peanut, and watermelon. Key perennial crops planted include mango, rubber, banana, coconut, coffee, tea, tamarind, pineapple, cardamom, plum, mandarin and orange, jackfruit, and jatropha. Figure 3 shows the total area under annual crops (excluding rice) and the total area under perennial crops as well as the share of annual and perennial crops.

Patterns in 2011

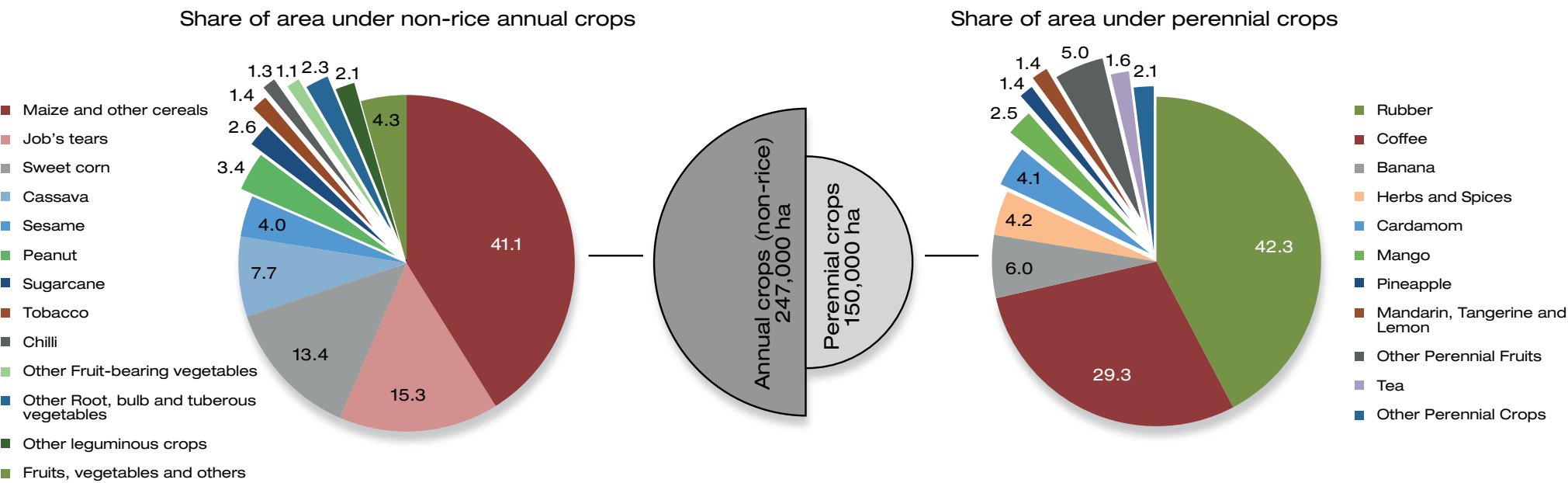
The population of the Lao PDR is made up of a high diversity of ethno-linguistic groups with various livelihoods practices and different farming systems. As displayed in the main map, there are wide variations in crop types (indicated by black dots of varying size) grown in villages across the Lao PDR – the highest being 87 crops grown by a single village. At the lower end, 78 percent of all villages (6,774 villages) grow under 30 crop types but considerable 22 percent of villages (1,869 villages) grow more than 30 crop types. As the village level choropleth map reveals, most households grow up to 5 crop types, but in some villages, households grow up to 25 crop types on average.

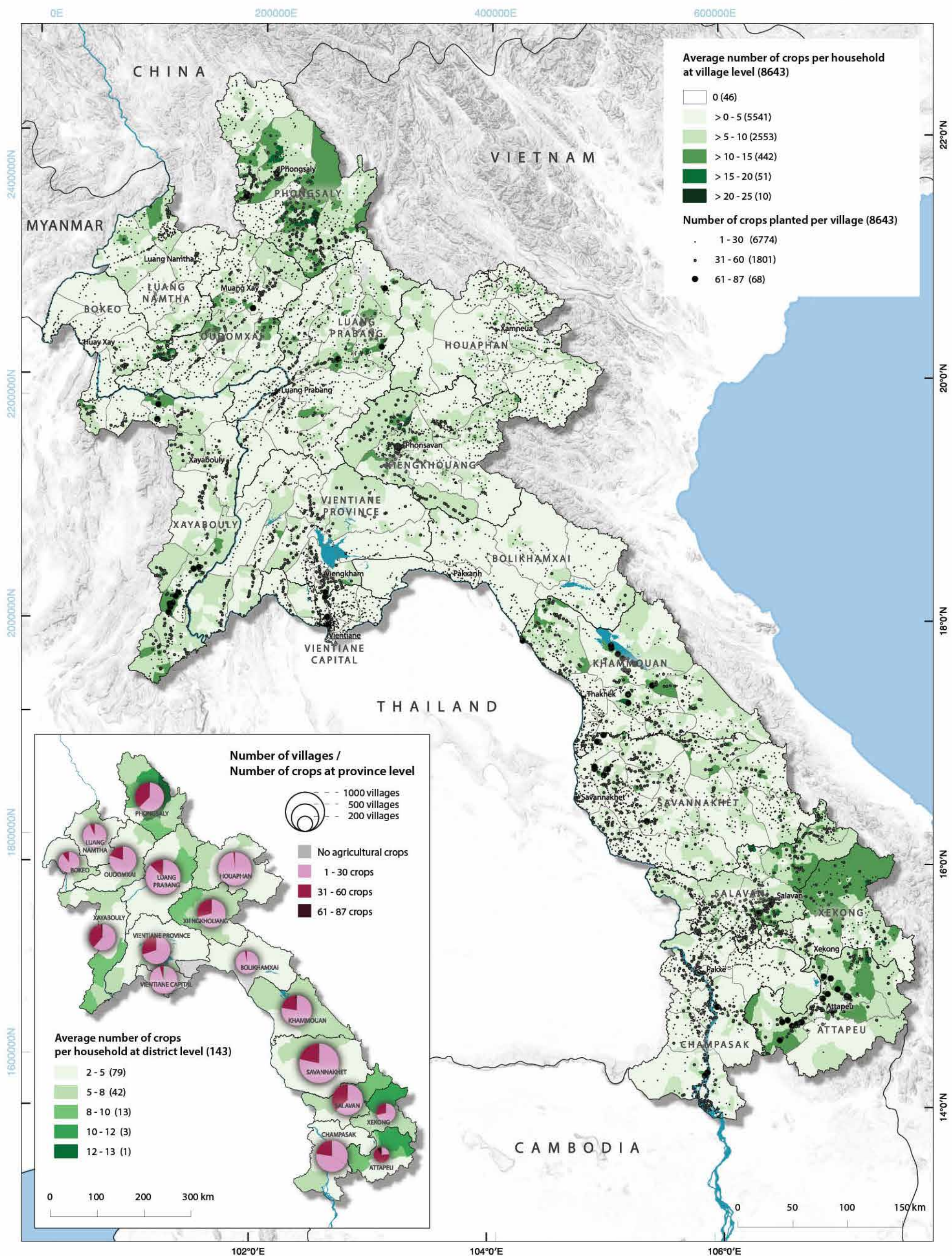
The small inset map shows the average number of crops per household at district level. Areas in the far southeast but also in the far north of the Lao PDR have high agro-biodiversity and cultivate 8 or more crops per household on average. In Attapeu Province, for instance, approximately 20 percent of the 150 villages grow 1 - 30 different crops, 70 percent grow 31 - 60 crops and 10 percent grow 61 - 87 crops. Another example is Houaphan Province, where almost all of the 98 percent of villages in the province grow 1 - 30 crops and the remaining 2 percent grow 31 - 60 different crops on average.

Interpretations

Despite significant economic changes over the last decades, the Lao PDR is still primarily an agrarian society. People in rural areas are still strongly dependent on agro-biodiversity resources for their livelihoods. As described above and illustrated in these maps, the majority of agricultural households still use a large number of crop types in their farming activities to ensure food security, diversify diets and add nutritional value, as well as to increase their income. As such, agro-biodiversity is particularly important to the poor and plays a key role in poverty reduction. However, the trend towards monoculture farming systems for commercial purposes in some regions has caused the decrease in (mostly perennial) crop diversity and boosted the negative, long-term impacts of agriculture on ecosystems and on land and forest resources.

Figure 3: Distribution of main annual and perennial crop types





C4 Upland rice in wet season

Introduction

Upland rice is the main crop grown in the northern uplands and along the Vietnam border, whereas relatively small areas are cultivated in central and southern Lao PDR. Upland rice is grown as a rain-fed crop on sloping land and is usually only grown during the wet season. Farmers normally grow upland rice for subsistence. Upland rice is traditionally planted under shifting cultivation or rotational cultivation and can be intercropped with a variety of crops for both family consumption and for market.

Upland rice is grown under shifting cultivation, often in rotational cultivation patterns which involve cutting and burning vegetation, planting rice seeds, weeding and finally harvesting (use of the plot for one year: “*hai lao*” or use of the plot for two years in a row: first year “*hai lao*” and second year “*hai lock*”) followed by a fallow period whose length depends on the regeneration capacity of the biomass, on soil fertility and also on land availability in the region. For the customary annual production of upland rice, land preparation occurs between January and April, planting between mid-April and May, weeding between June and August, and harvesting in September or October, depending on the maturation time of the upland rice variety. Weeding is one of the most difficult and labour intensive tasks involved in upland rice production. It is done usually by women and children three to five times per crop depending on the length of the previous fallow (Linquist *et al.*, 2006).

Patterns in 2011

The total area under upland rice in the Lao PDR is approximately 210,000 ha. There are, however, serious methodological problems to quantifying the exact extent of shifting cultivation (Messerli *et al.*, 2009). Considering that upland rice is grown in rotational cultivation systems which include fallow areas, this total area could be eight to nine times higher than measured here (depending on the fallow length).

The main map illustrates which districts have the highest absolute areas of upland rice: Pha-oudom District (5,600 ha) in Bokeo Province, Xai (4,700 ha) in Oudomxai, and Nambak (4,600 ha) in Luang Prabang Province. Less upland rice is grown outside of these mountainous regions, such as around Vientiane Capital and along the Mekong River to the south.

The main map shows the proportion of agricultural land under upland rice at the village level. In 2011, 4,326 villages or half of all villages in the Lao PDR cultivated upland rice. Especially around Pha-oudom District, many villages devote more than 75 percent of their agricultural land to upland rice.

240,000 households grow upland rice, which constitutes 30 percent of all 781,600 agricultural households countrywide. Oudomxai has the most households farming upland rice, with 25,507 households, whereas Vientiane Capital, the most urbanized area in the Lao PDR, has only 767 agricultural households farming upland rice.

The district level inset map depicts the average area of upland rice per producing household. In two districts in Vientiane Capital and in Xaibouly District in Savannakhet, households have no upland rice. In contrast, seven districts have a mean area over 1.0 ha per producing household, all of which are located in northwestern Lao PDR, including Pha-oudom District in Bokeo, which also has the largest total area under upland rice with 5,600 ha. The districts with small mean areas of upland rice per planting household are predominantly located in the lowlands from Vientiane Capital along the Mekong River, down to the south.

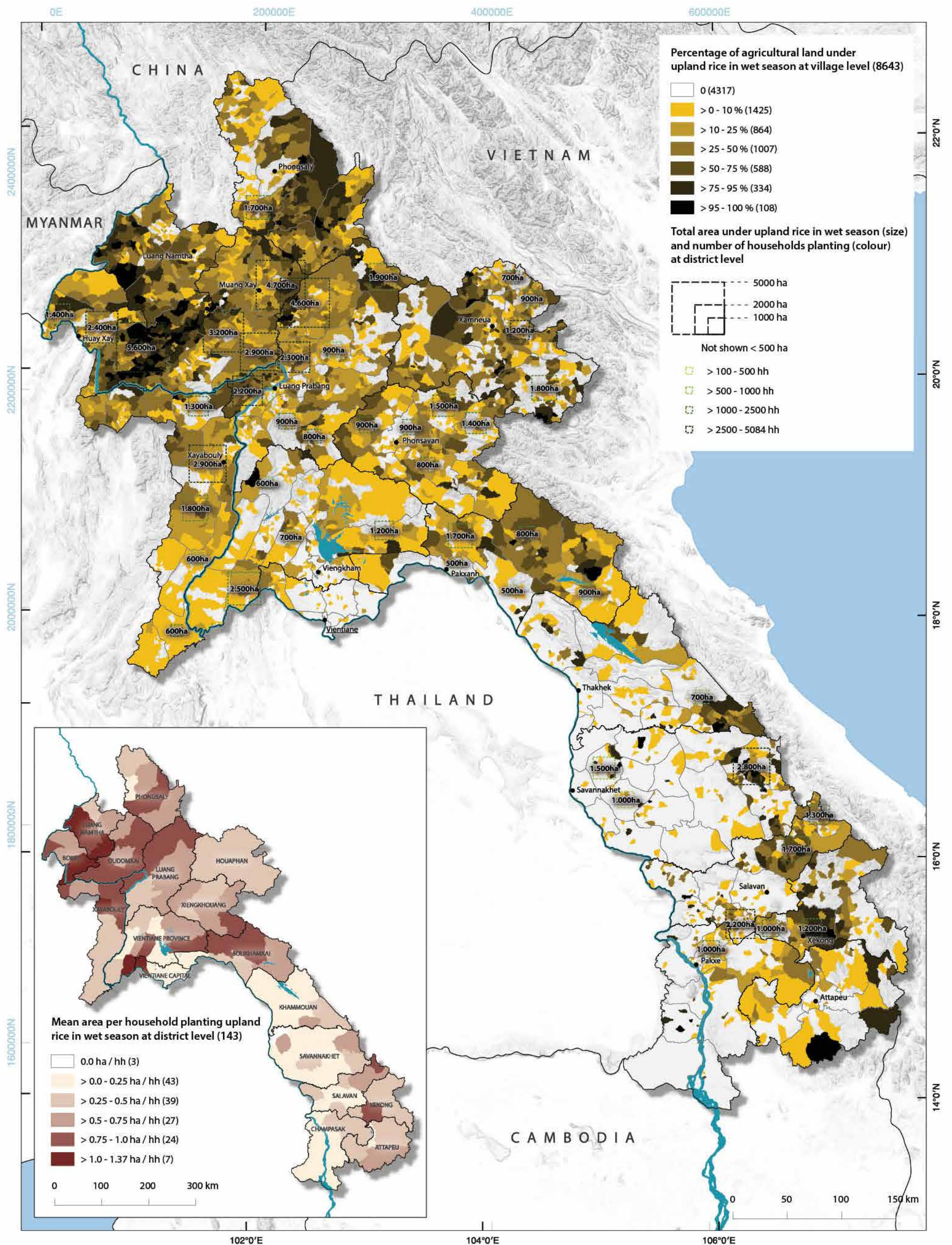
Interpretations

The dominance of upland rice in the north is due to the fact that this region's topography is primarily hilly and mountainous with few plains suitable for paddy rice cultivation and low potential for irrigation development. Conversely, due to the advantage of having more flat land suitable for rain-fed and irrigated rice cultivation in the central and southern regions, a low recorded proportion of agricultural land is used for upland rice there.

The absolute area under upland rice cultivation increased slightly across the Lao PDR from 199,197 ha in 1999 to 212,009 ha in 2011. However, the number of upland rice growing households has decreased from 260,000 to 240,000.

Finally, the accuracy of these numbers measuring cultivation of upland rice may be affected by the fact that, after decades of state efforts to discourage upland rice cultivation through shifting cultivation systems, it is a sensitive topic to interview households about. In the 1990s, the GoL with support from development partners started a range of shifting cultivation eradication programs. Shifting cultivation was considered an antiquated form of agricultural production and an obstacle to the country's development. In many areas, upland rice areas were replaced by cash crops such as maize, rubber, Job's tears, banana, or cassava plantations in many northern provinces. A three-plot rotational cultivation system was also introduced, but because this system shortened fallow periods, it led to an increase in soil degradation, erosion, and the occurrence of weeds and pests. Today the term “eradication” has been replaced by “stabilization” to reflect a shift in government approach. However, food security especially in the upland areas is still one of the Government key policies especially in upland areas, and due to a lack of alternatives, rotational cultivation is tolerated. Today, the government's focus is more on the improvement of upland rice cropping systems that are environmentally sustainable and suitable for upland environments.

C4 Upland rice in wet season



C5 Lowland rice in wet season

Introduction

Wet season lowland rice, also called rain-fed lowland rice, is grown in bunded, flooded paddy fields, mainly in the flat regions of the country in the Mekong River Valley but also in other valleys, depressions and flat areas throughout the upland regions. Lowland rice cultivation generally commences at the beginning of the wet season, with land preparation consisting of two stages: first ploughing and then puddling or harrowing. Land preparation is mostly done using two-wheel handheld tractors (*toktoks*), which have largely replaced buffaloes in many places. Rice seeds are sown in a nursery seedbed, and then young seedlings are pulled out and transplanted in the main fields, though transplanting may be deferred if the onset of rainfall is delayed. The harvesting period is normally between October and November, depending on the maturation period of the varieties planted. Paddy fields in areas with access to irrigation systems are also supplemented with irrigation water during dry periods of the wet season. After harvest, during the dry season, paddy fields in non-irrigated areas are left unplanted and are grazed by livestock, whereas fields are planted with rice or other crops (such as tobacco) in areas with irrigation.

Patterns in 2011

The total area under wet season lowland rice is approximately 735,000 ha and, as the main map shows, and a large proportion is grown in the lowlands of central and southern Lao PDR. The green squares indicate the area under wet season lowland rice per district, the highest being 26,400 ha in Champhon District, Savannakhet Province, where almost one quarter of the entire area of that district is under rain-fed paddy rice (106,500 ha in that district alone). Savannakhet Province is known for its extensive contribution to rice production in the Lao PDR, with almost 200,000 ha under wet rice production (27 percent of the total wet season lowland rice area). The districts in other provinces surrounding Savannakhet also have large areas under wet season lowland rice, with the exceptions of those in Pakxong District on the Bolaven Plateau in Champasak (where coffee production dominates) and the very hilly eastern region, especially in Xekong.

There is a range in the proportion of all households cultivating wet season lowland rice across different areas of the country. In Champhon District in Savannakhet Province, for example, more than 10,000 households farm wet season lowland rice. In total, 569,756 households or 70 percent of all agricultural households grow wet season lowland rice. Savannakhet's 98,635 households represent 17 percent of all households in the Lao PDR cultivating wet season lowland rice.

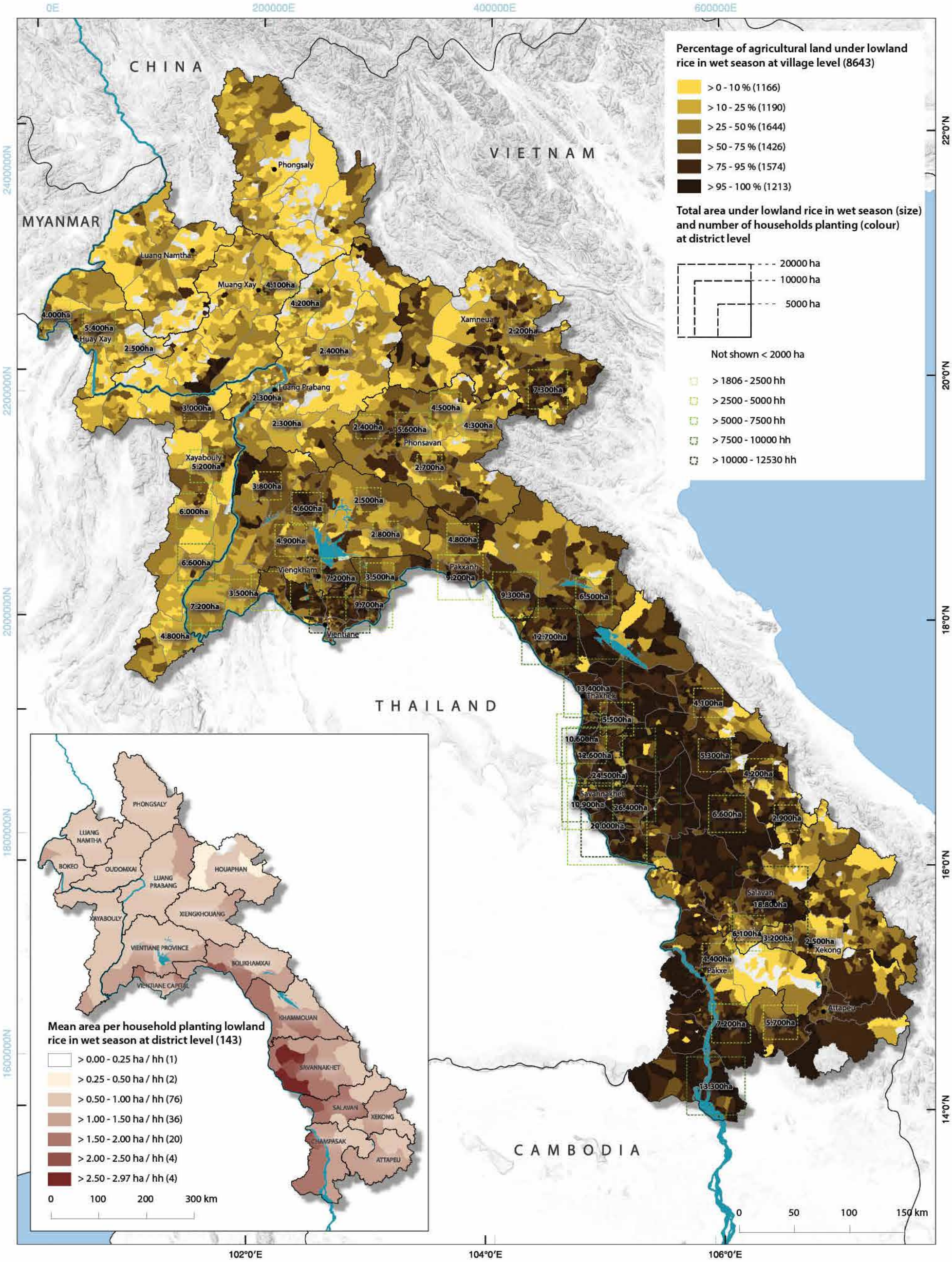
Meanwhile, 430 villages or 5 percent nationally do not cultivate any lowland rice. These are mainly located in the northern regions where, because of steep slopes, there is not much space appropriate for establishing rice paddies, or in the centre of Vientiane Capital, the most urban area in the Lao PDR where less agriculture is done generally. All other villages (95 percent nationally) plant at least some lowland rice in the wet season, and about half of them devote more than 50 percent of their agricultural land to wet season lowland rice.

The district level inset map shows the average area of wet season lowland rice per producing household. 8 districts have a higher average of 2.0 ha per household, all of them located alongside the Mekong River Valley in central and southern Lao PDR. In the mountainous regions of the country the average area is considerably lower.

Interpretations

The dominance of wet season lowland rice in the central and southern regions is largely due to the topography of the land. Many large plains along the Mekong River Corridor suitable for lowland rice cultivation are concentrated in these regions. Conversely, the northern provinces are occupied mostly by steep uplands which lack flat areas suitable for rice paddy establishment. Moreover, many farmers in lowland areas of the northern regions prefer planting other cash crops that render higher economic returns to lowland rice. Amongst those products are watermelon, green beans, chilli and various kinds of vegetables.

Ensuring national food security and the commercialization of rice by boosting rice production in lowland areas, especially during the wet season, is part of the GoL's prioritized agenda (MAF, 2015). Some of the development programs aimed at supporting the GoL's agenda focus on rice promotion and extension in the lowland regions. These programs include the construction of large irrigation schemes since the 1990s, and improving rice varieties for higher tolerance to drought and floods and for faster growth.



C6 Lowland rice in dry season

Introduction

In areas with irrigation systems, commonly in the lowland regions, farmers are able to grow rice also during the dry season. Still, more management is required for dry season than wet season lowland rice, as a higher degree of management of irrigation water, use of fertilizers, and control of insects and weeds is expended during the dry season (Linguist *et al.*, 2006).

The cropping cycle and management practices for irrigated lowland rice are generally similar to that of rain-fed lowland rice, both of which are grown in bunded, flooded paddy fields. After harvesting the wet season crop, rice fields are irrigated and land preparation starts. The nursery seedbed is sown in December and the seedlings are transplanted to other areas by early January. Harvesting takes place in April or May, depending on the type and maturing time of different varieties.

Patterns in 2011

There is far less lowland rice cultivated during the dry season than during the wet season, due primarily to a lack of irrigation facilities. In 2011, the total area of irrigated dry season lowland rice in the Lao PDR was 52,500 ha, which represents only 7 percent of the total lowland rice cultivation area. As with wet season lowland rice, dry season lowland rice cultivation areas are mainly concentrated in the Mekong River Valley, where the Mekong River and its tributaries supply water to irrigation systems.

As can be seen on the main map, most of the irrigated dry season rice cultivation areas are located in Vientiane Capital, in neighbouring districts of Vientiane Province, and also in some regions close to the Mekong River. The districts south of Thakhek in Khammouan Province also stand out as areas of extensive production, namely Nongbok (2,000 ha, 2,277 households) and Xaybouly (2,900 ha, 3,800 households). The southernmost district in the Lao PDR, Khong District, has 1,700 ha under irrigated dry season lowland rice cultivation, while Salavan District, located at the Xe Don River, has 2,000 ha, and the region around Attapeu town, located on the Xe Kong River, also have significant irrigated dry season lowland rice areas. Champhon District in Savannakhet, with 4,100 ha, has the largest area in the country of both irrigated dry season lowland rice and of wet season lowland rice. These areas in Champhon have an existing paddy infrastructure used during the wet season and include the Xe Champhon wetlands, which are the second largest wetlands in the Lao PDR and constitute a major water source for irrigation in this region.

In total, 5,534 villages or 64 percent of all villages in the Lao PDR do not grow any irrigated lowland rice in the dry season. 2,052 villages only use up to 10 percent of their agricultural land for irrigated lowland rice. These villages are scattered across the country with exceptions in Xiengkhouang, western Houaphan, eastern Luang Prabang, Phongsaly and eastern Savannakhet.

The small map shows the mean area of irrigated lowland rice planted per producing household in dry season at the district level. The national average is 0.6 ha per household but some districts in western Savannakhet, Vientiane Capital and Champasak have higher averages. In Xiengkhouang and Houaphan, the mean per household is under 0.25 ha.

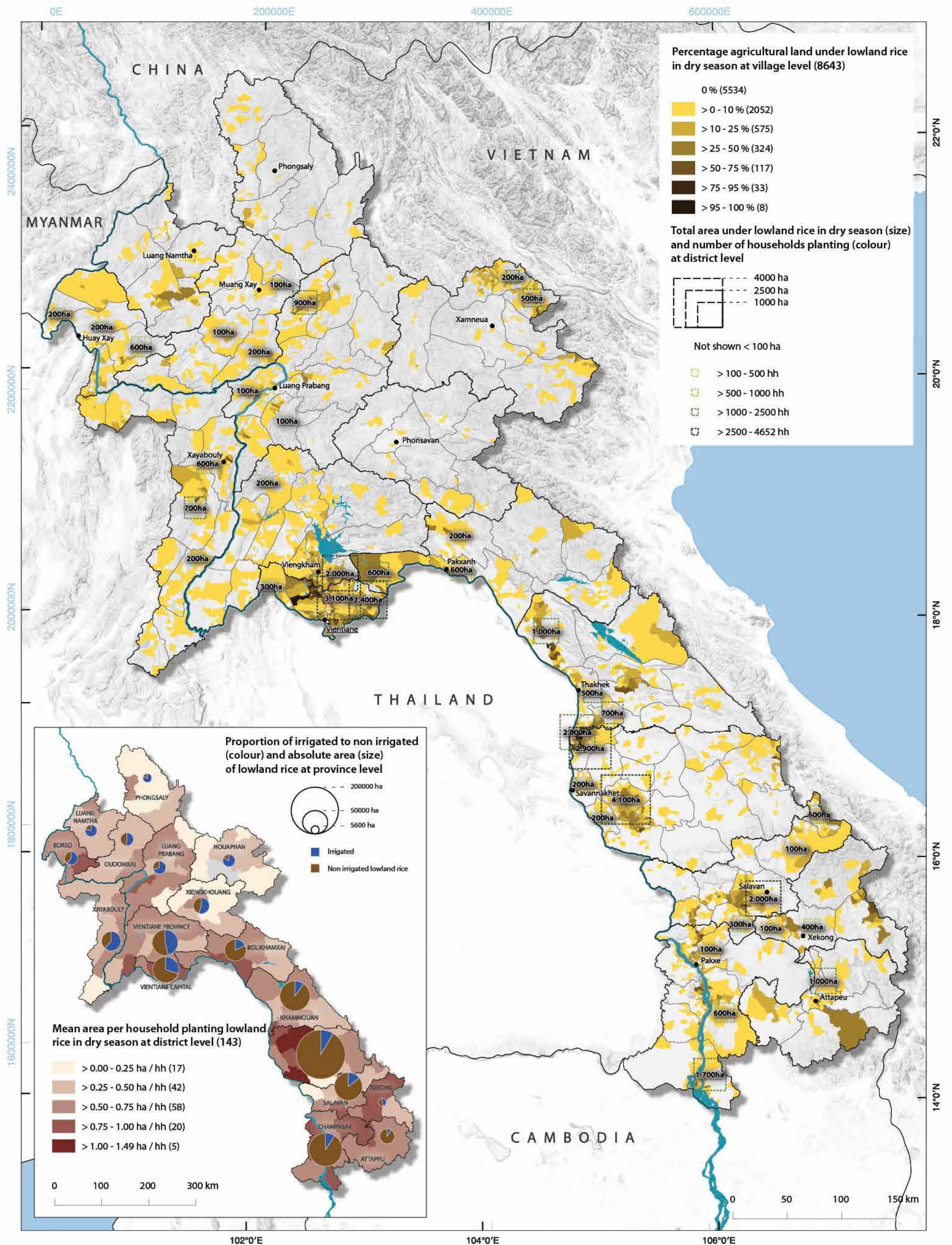
Additionally, the small inset map shows how much of the total planted lowland rice (over two seasons) is irrigated and not irrigated. In Savannakhet, for example, more than 200,000 ha of lowland rice are grown, of which under 10 percent are irrigated, while in Houaphan only 13,500 ha are grown but more than 80 percent are irrigated.

Interpretations

Although the GoL has invested extensive resources into the development of irrigation facilities since 1996, many areas still lack access to irrigation. The low efficiency of many pumping stations (which often use old technology and operate at high energy consumption) coupled with insufficient maintenance of existing irrigation facilities, especially main and secondary canals, has led to an increase in rice production costs and consequently many irrigation schemes were abandoned and unused.

Further investment in new construction and the rehabilitation of damaged or outdated irrigation facilities should be done in parallel with appropriate operations and maintenance of existing irrigation systems. Subsidizing operation costs such as electricity and water fees is on the GoL's agenda as a way to ensure national food security and the commercialization of rice production (MAF, 2015). Apart from large-scale irrigation schemes, the GoL has recently promoted gravity-fed small scale irrigation systems as well as tapping into village groundwater sources to both reduce production costs and increase rice production in the dry season.

C6 Lowland rice in dry season



C7 Development of rice areas

Introduction

Rice is the most essential food crop planted in the Lao PDR and rice production is the main farming activity, accounting for more than 63 percent of the total area under cultivation throughout the country. Rice in the Lao PDR is grown under three main agro-ecosystems, namely, rain-fed lowlands (wet season lowland rice), irrigated lowlands (dry season lowland rice), and rain-fed uplands (wet season upland rice). Rain-fed lowland rice is grown in bunded fields flooded for at least part of the season and water comes from natural rainfall. Irrigated lowland rice is grown in bunded fields flooded for at least part of the season and irrigated water is used. Rain-fed upland rice is grown in unbunded fields on sloping land under shifting cultivation systems and depends on rainfall (Linquist *et al.*, 2006).

Patterns in 2011

The total rice cultivation area throughout the Lao PDR is nearly one million ha. Wet season lowland rice dominates rice cultivation and accounts for 72 percent (735,000 ha) of the total area under rice production, whereas dry season lowland rice and wet season upland rice constitute only 6 percent (52,500 ha) and 17 percent (210,000 ha, without counting fallow areas - see C4) of the total area under rice production respectively. Wet season lowland rice dominates mainly in the lowlands in the central and southern provinces, but also in flat areas, mainly in valleys alongside rivers, or where rice terraces have been established on slopes in the mountainous northern and very eastern parts of the Lao PDR along the Vietnam border. Savannakhet and Champasak cover around 30 percent of the total wet season lowland rice cultivation area. Wet season upland rice cultivation occurs more in the mountainous northern and very eastern parts of the country. Irrigated dry season lowland rice is mainly grown in Vientiane Capital and along the Mekong River in the central and southern provinces. Figure 4 shows the total area of upland rice, lowland rice in wet season and lowland rice in dry season per province.

Changes between 1999 and 2011

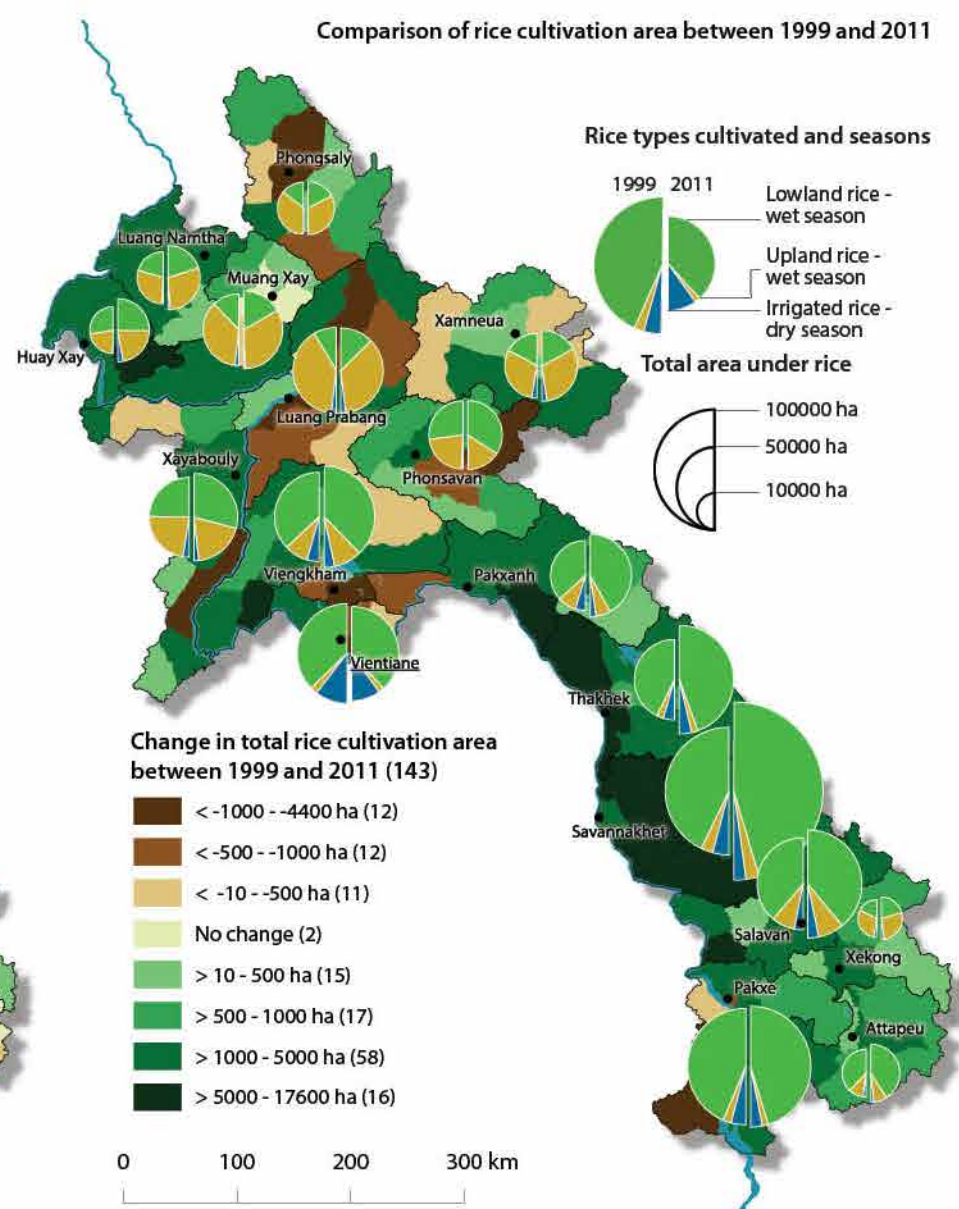
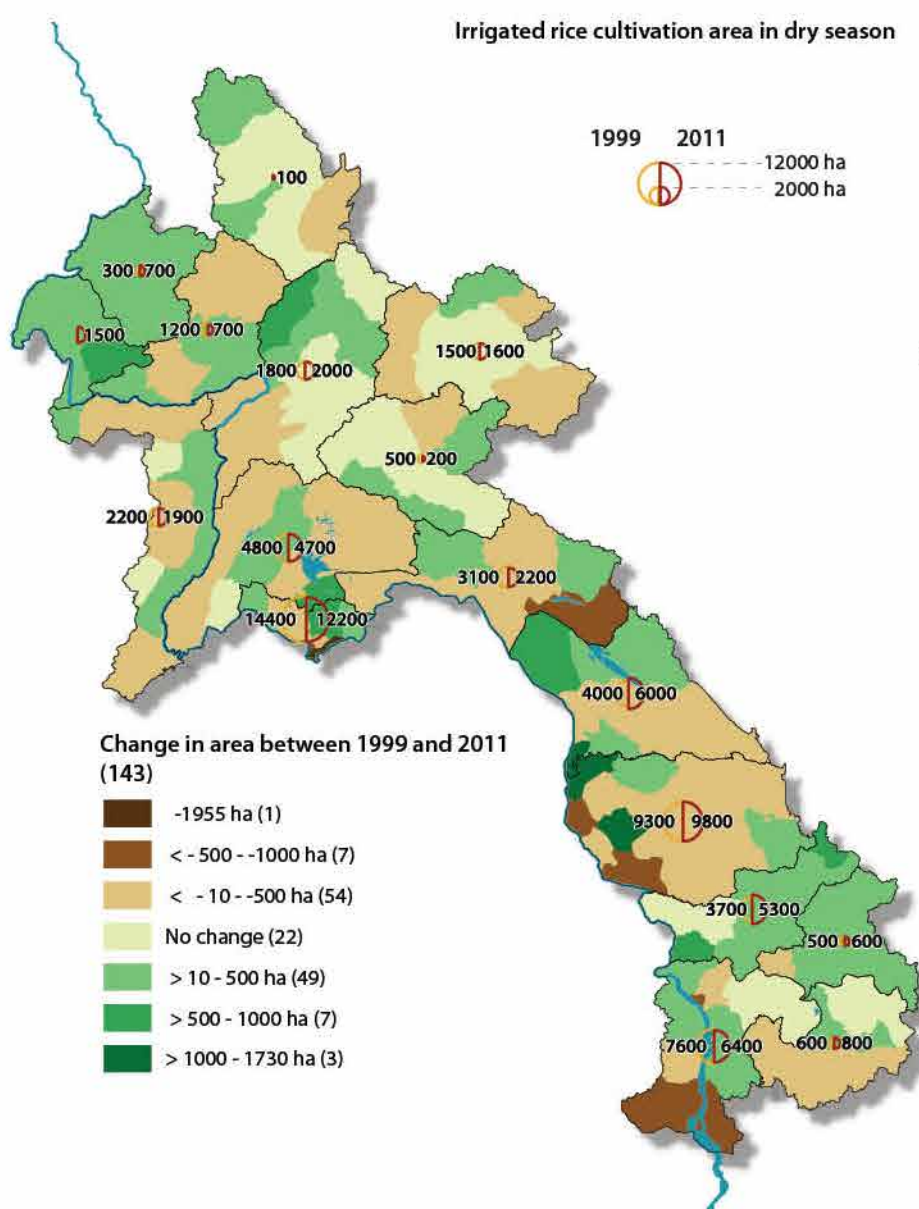
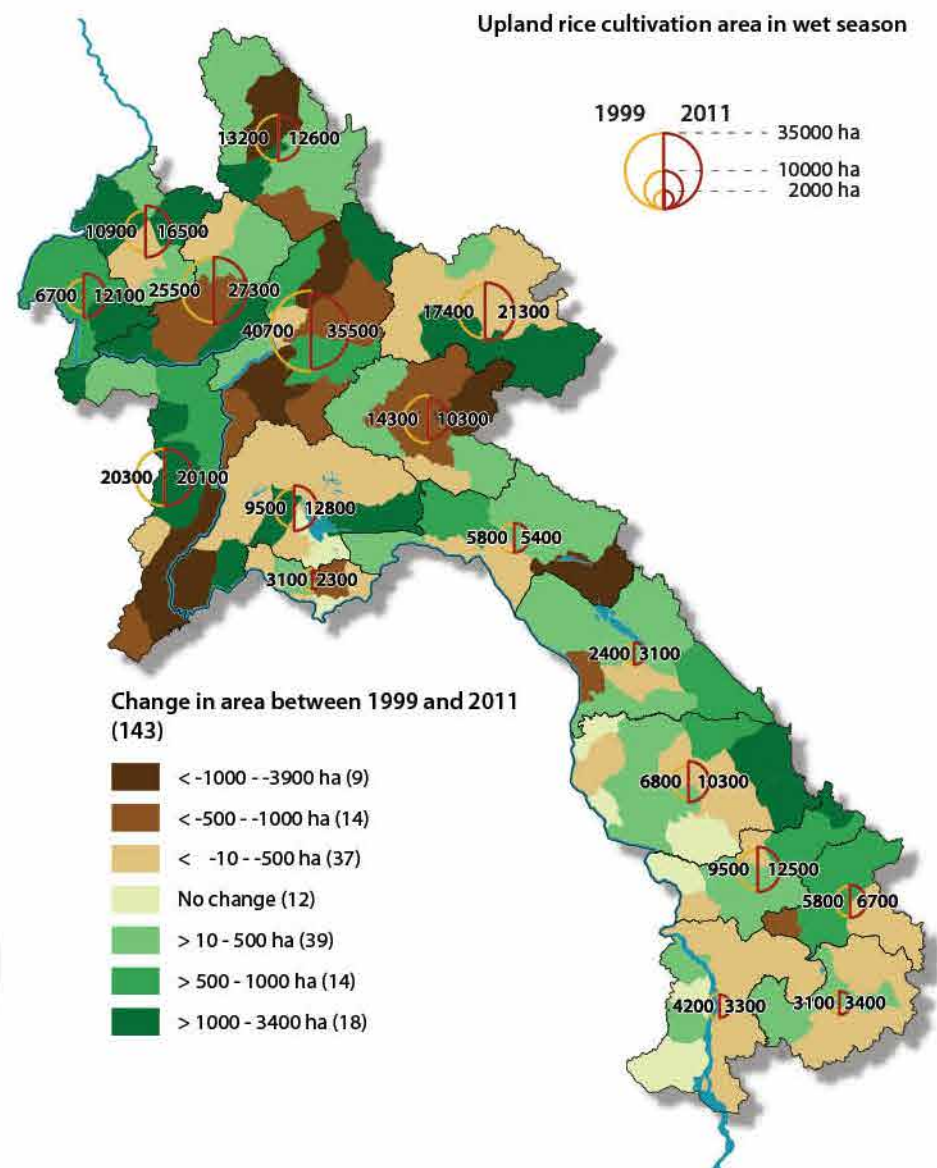
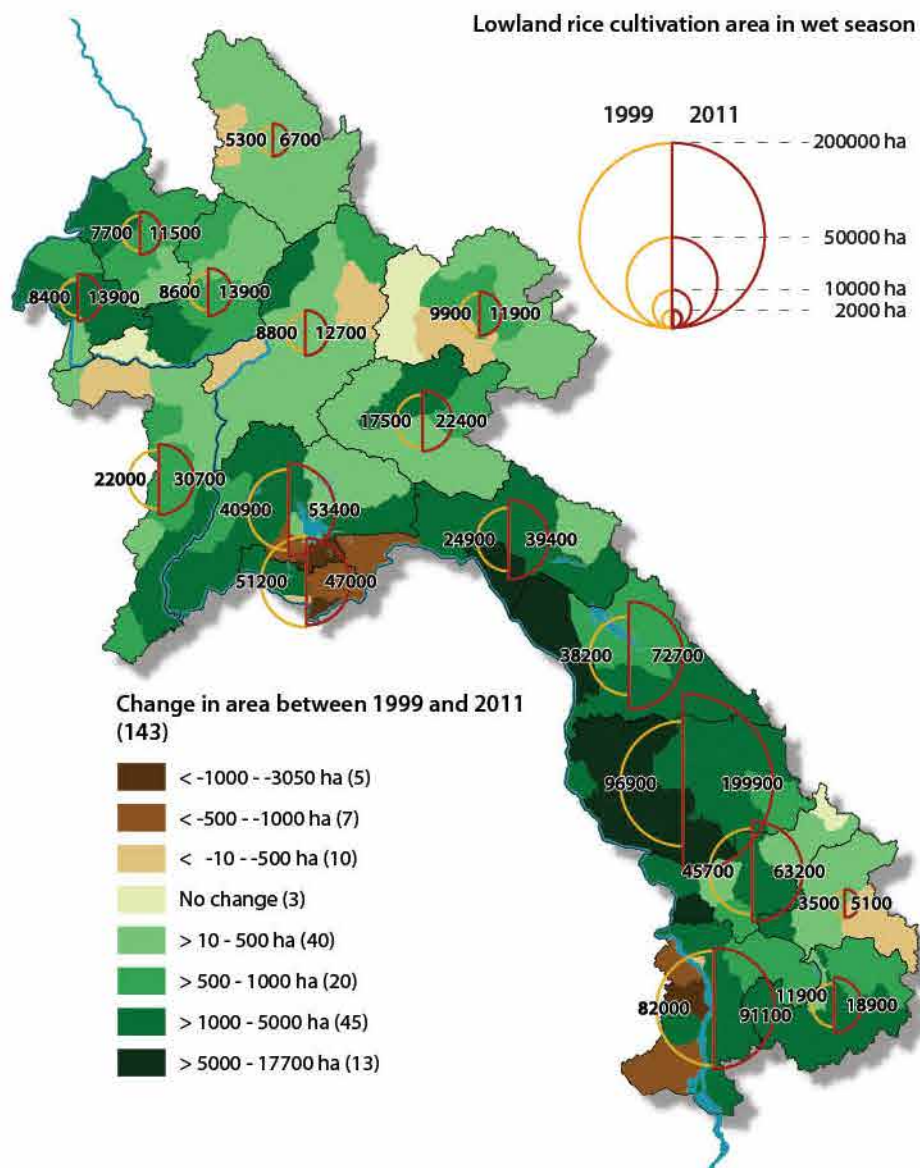
In the Lao PDR, between 1999 and 2011, the total rice cultivation area increased by over 200,000 ha from 738,187 ha to 997,500 ha – an increase of 35 percent. In terms of the contribution of each rice agro-ecosystem to the total rice area, during 1999 and 2011, wet season lowland rice continued to be the dominant form of rice production and accounted for by far the largest area (72 percent of total rice area in 2011), which was an increase from 65 percent in 1999. The share of dry season lowland rice area dropped slightly from 8 percent in 1999 to 6 percent in 2011. The contribution of wet season upland rice to total rice area decreased from 27 percent in 1999 to 22 percent in 2011.

The provinces with the largest total area under rice cultivation in both 1999 and 2011 were Savannakhet and Champasak Provinces. However, over the intervening decade, the largest increase in total rice area occurred in Savannakhet Province which experienced an increase of 107,000 ha (94 percent or nearly double). Next are Khammouan and Salavan Provinces with a total increase of 37,082 ha (83 percent) and 22,043 ha (37 percent) respectively. Champasak Province experienced a moderate increase of 6,887 ha (15 percent). Nonetheless, Vientiane Capital and Luang Prabang recorded a decline in the total area under rice production of 7,279 ha (11 percent) and 1,045 ha (2 percent) respectively. At district level, about 75 percent of all 143 districts increased the total rice area.

The wet season lowland rice area in the Lao PDR increased by almost 50 percent, from 483,360 ha in 1999 to 714,353 ha in 2011. As the top left map demonstrates, the area under wet season lowland rice cultivation increased especially in the western part of the central region. Almost all districts starting from Pakkading District in Bolikhamxai down to Khongxedon in Salavan saw increases in the area under wet season lowland rice. In the areas in and around Vientiane Capital and in western Champasak Province, the area under wet season lowland rice decreased.

Unlike in the wet season, the dry season irrigated lowland rice area throughout the Lao PDR stayed more or less unchanged with 55,630 ha in 1999 and 56,769 ha in 2011. As the bottom left map depicts, the changes in most regions were marginal. Hadxayfong District in Vientiane Capital experienced the most significant decrease. Almost 2,000 ha of irrigated paddy land was lost here due to rises in the urban population and the resulting expansion of urban development. Champhon District in Savannakhet with its large wetland areas experienced the most significant increase in irrigated paddy area.

The wet season upland rice area increased slightly from 199,197 ha in 1999 to 212,009 ha in 2011. As can be seen in the top right map, in general, changes are very scattered across all districts in the country. Most striking are the southern districts in Xayabouly where the upland rice cultivation area declined a few hundred ha, and by contrast, the northern parts of Xayabouly increased their total upland rice area some hundred ha. In sum, the total national upland rice area stayed in absolute numbers stable.



Interpretations

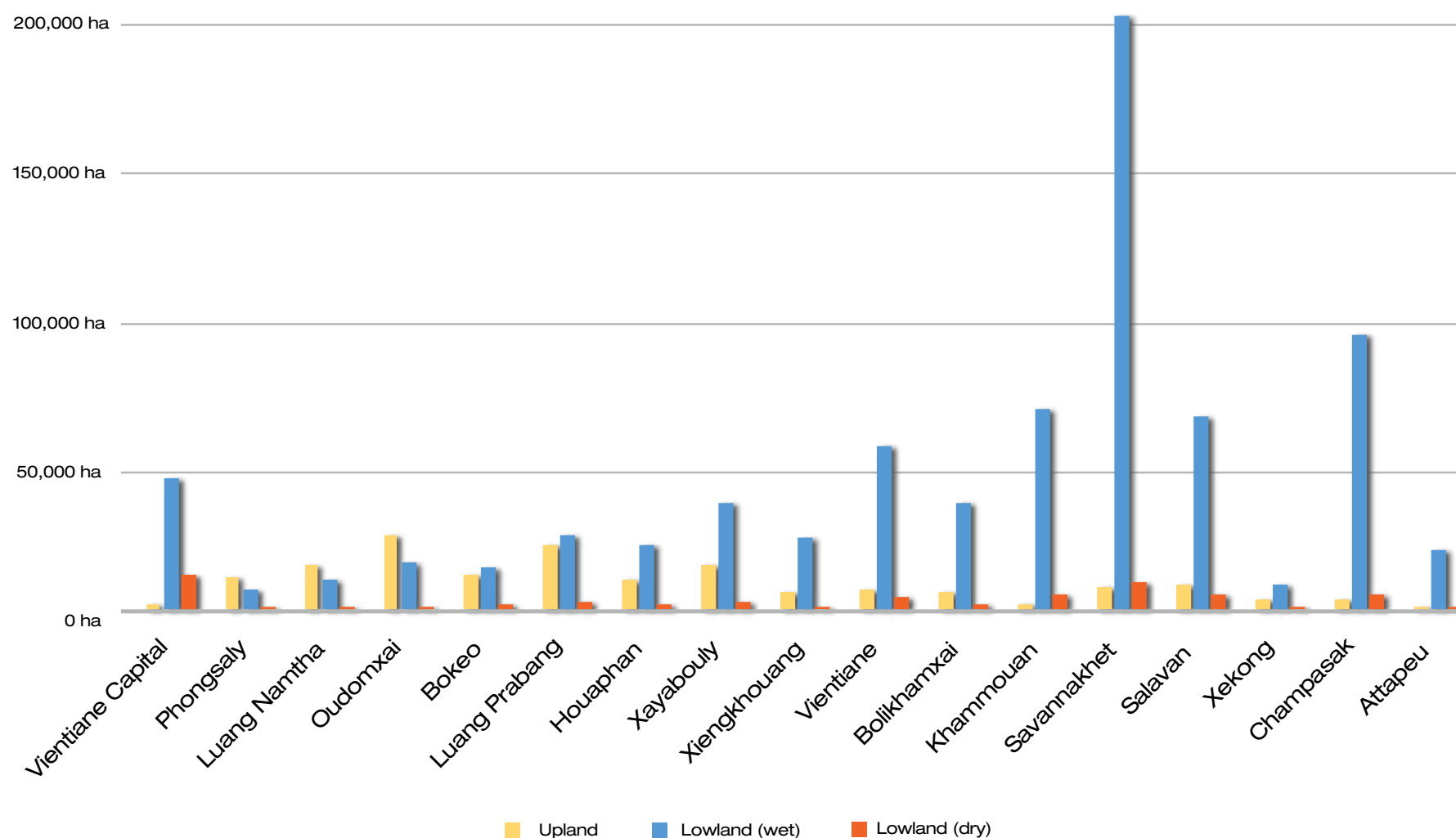
The steady growth in the Lao rice sector from 1999 to 2011 was primarily due to the adoption of new rice production technologies including improved varieties, inorganic fertilisers and new management practices.

The largest increase in area of total rice cultivation, which occurred in Savannakhet and Khammouan, was largely due to key government policies aimed at ensuring food security, promoting commodity production and increasing farmers' incomes. Irrigation schemes invested in by the government to support those priorities have been constructed in these two provinces, contributing more to the enhancement of wet season lowland rice production area, especially during drought years, than to the area under irrigated dry season lowland rice. Decreases in the area under rice in Vientiane Capital and Luang Prabang Province were largely related to rapid urban expansion; many rice growing areas have been replaced with buildings, roads and recreation facilities. In northern Lao PDR there are limited lowland areas for expanding rice production and in some of the lowland areas there are other cash crops such as watermelon, green beans, and various kinds of vegetables planted which require less water and are in high demand.

The area under dry season irrigated lowland rice increased only marginally. High costs of growing dry season rice due to expensive water fees, low efficiency of pumping stations, insufficient maintenance of irrigation facilities, increased wage labour rates caused by outmigration of labour from rural areas led to this development.

The area under rain-fed upland rice production stayed stable between 1999 and 2011. Farmers in the uplands have continued to plant rice under shifting cultivation systems as the main source for their livelihoods. The approach of stabilization of shifting cultivation through promoting rotational cultivation instead can help farmers to cultivate their upland fields in a more visible, systematic way which may also reduce forest impacts.

Figure 4: Total area of upland rice, lowland rice in wet season and lowland rice in dry season in 2010/11 by province





C8 Development of rice varieties

Introduction

In the Lao PDR 90 percent of rice production areas are planted with glutinous rice. Adopting new rice production technologies (e.g. improved varieties, inorganic fertilisers, and management practices) helps to increase rice production. Among these technologies, the adoption of improved varieties since the 1990s has been a key factor in achieving significant productivity increases.

Before the early 1990s, farmers primarily cultivated local and traditional rice varieties. Improved rice varieties were introduced mainly from Thailand and Vietnam and began to be used across small rice production areas along the Mekong Valley in the early 1990s. Around the same period, in collaboration with the International Rice Research Institute (IRRI), the Lao National Rice Research Program developed and released some improved Lao glutinous rice varieties suitable particularly for lowland areas. Subsequently, local rice research and seed multiplication centres have been able to produce more improved Lao glutinous rice varieties throughout the country on a regular basis (Inthapanya *et al.*, 2006).

Lao farmers have gradually replaced local or traditional varieties with improved rice varieties to boost rice productivity and respond to recent increases in market demand. However, in parallel with the adoption of new rice varieties, farmers continue to grow traditional and indigenous varieties of rice, mostly for household consumption.

Patterns in 2011

Improved rice varieties have been widely adopted in the central and southern regions, while farmers in the northern region still mainly plant local upland rice varieties. Improved rice varieties now cover 70 - 80 percent of rice growing areas in the lowlands of most provinces located along the Mekong River. In contrast, almost all of the rain-fed upland rice areas are still planted with local varieties.

As the left map shows, farmers in the north plant slow-maturing glutinous rice varieties in almost half of the total glutinous rice cultivation areas, whereas farmers elsewhere plant more early-maturing and medium-maturing rice varieties. On average, 87 percent of the rice cultivation area is planted with early- and medium-maturing varieties in the south, and 75 percent in central Lao PDR.

Changes between 1999 and 2011

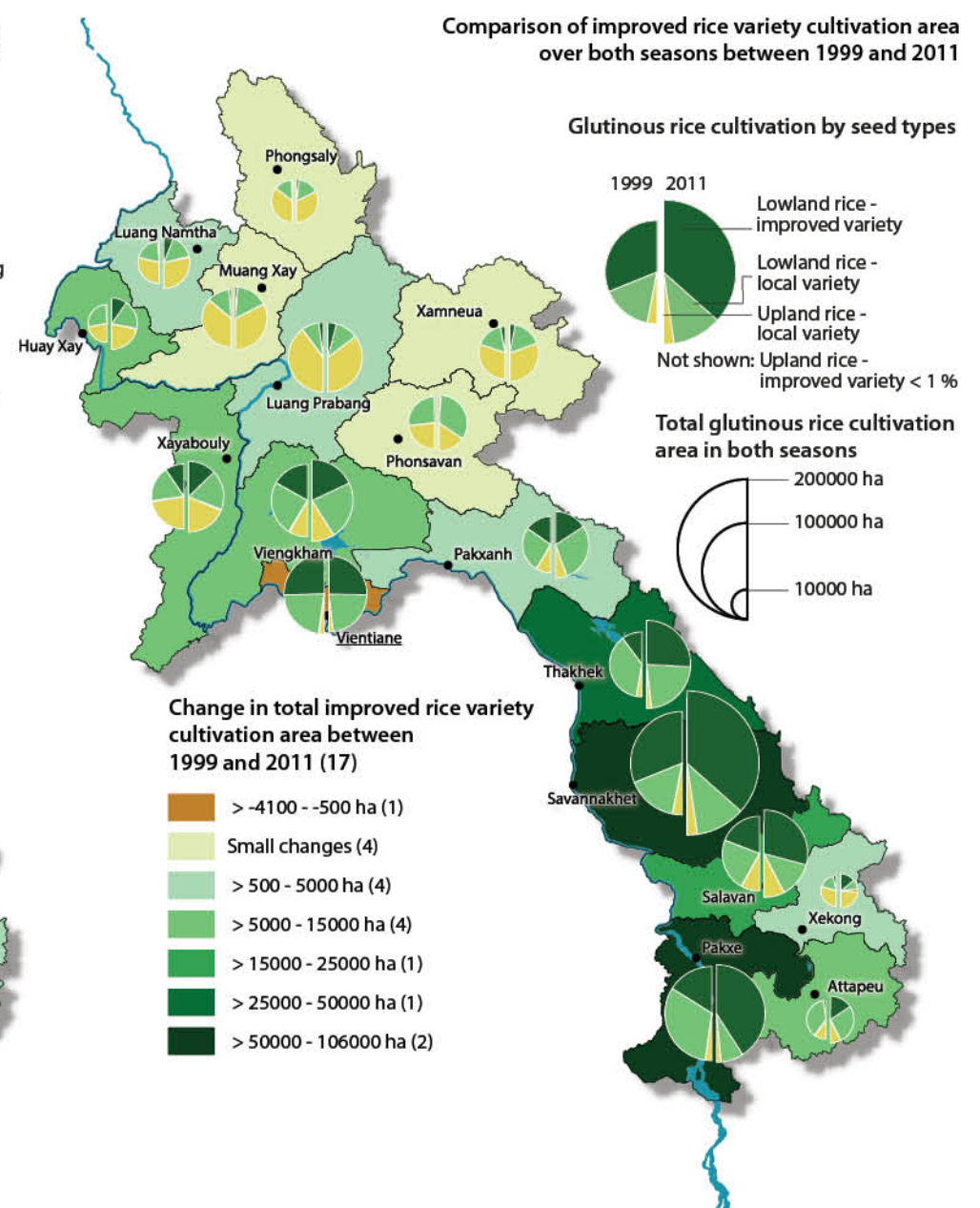
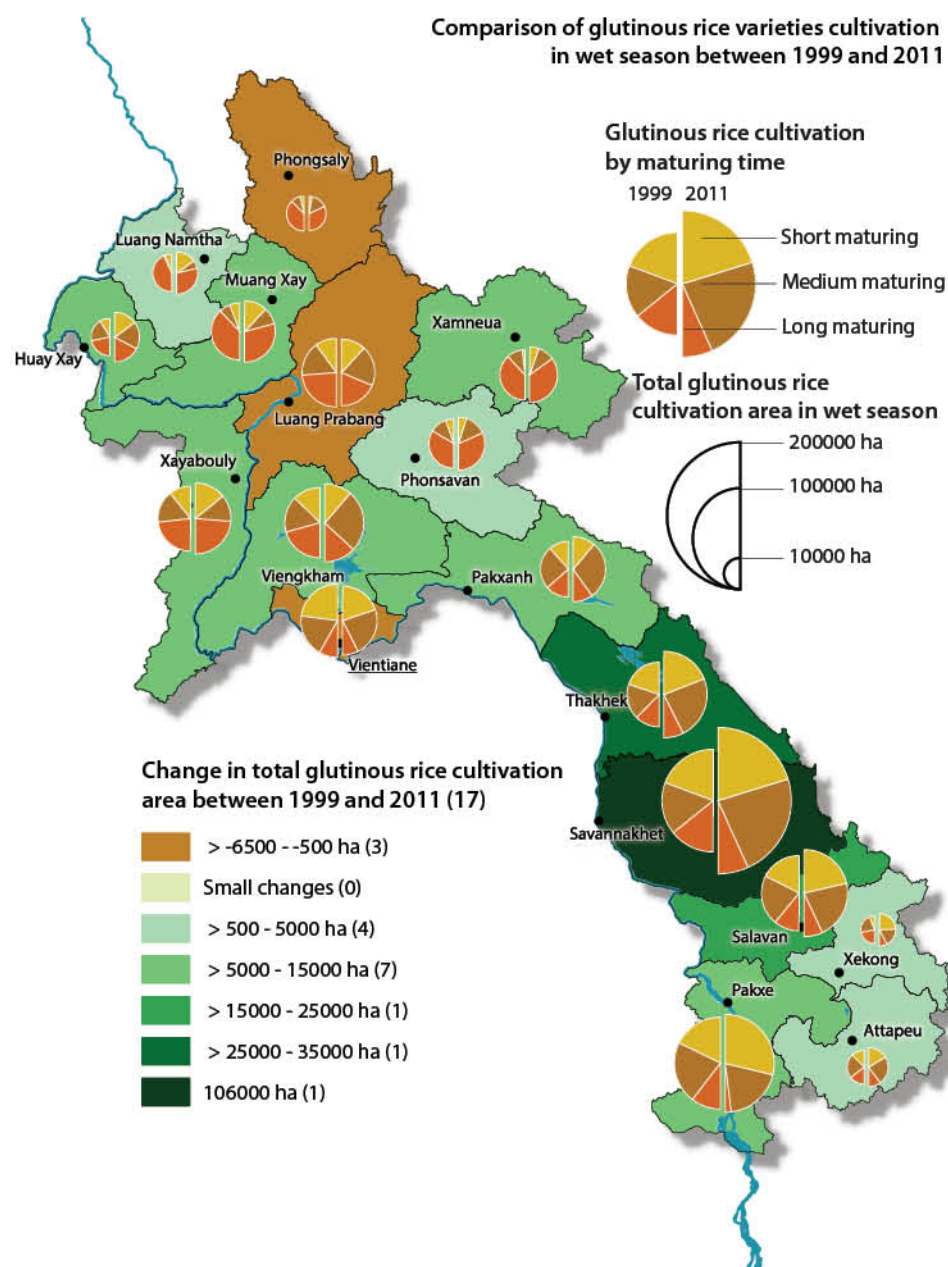
Overall, the area under glutinous rice production increased throughout the Lao PDR between 1999 and 2011, from 627,544 ha to 848,079 ha. The largest increase occurred in Savannakhet Province (by 106,000 ha). In contrast, Vientiane Capital experienced a decrease of about 6,328 ha (from 51,900 ha in 1999 to 45,572 ha in 2011).

The area under improved rice varieties nationally increased from 19 percent in 1999 to about 31 percent in 2011. In the southern provinces, the use of improved rice varieties has drastically increased, whereas the use of local varieties has dramatically decreased. In the northern provinces, farmers still cultivate mostly local rice varieties, primarily for household consumption rather than for markets. Exceptions are some lowland areas suitable for rice production in Xayabouly and in Bokeo.

Interpretations

The high adoption of improved rice varieties in the lowlands in central and southern Lao PDR is largely due to these regions' access to new varieties. They are closer to the main rice research and seed multiplication centres, namely Naphork Research Centre in Vientiane Capital, Thasano Research Centre in Savannakhet Province, and Phon Ngam Research Centre in Champasak Province. The extension services provided by the government and various donor projects through these centres have played an important role in Lao farmers' adoption of new rice varieties. Just a few areas have seen a decline in the total area of glutinous rice planted, for example Vientiane Capital which experienced rapid urbanization between 1999 and 2011.

Finally, in the last decade, there was a remarkable shift from planting glutinous to non-glutinous rice varieties. In response to growing market demand and resultant higher prices, farmers are gradually switching to growing more non-glutinous rice varieties. The shift to more non-glutinous varieties was promoted in the Agriculture and Forestry Development Strategy 2025, which includes a plan to increase the production ratio of non-glutinous rice to 30 percent of the national rice cultivation area (MAF, 2015).



C9 Main annual crops

Introduction

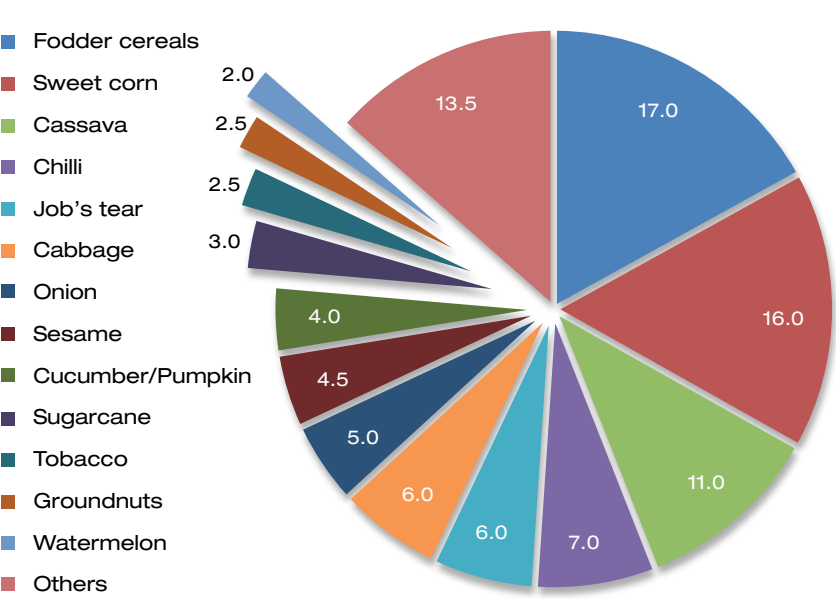
Of all agricultural land in the Lao PDR, 80 percent is devoted to annual crop cultivation (1.19 million hectares). A vast majority of this area is under rice production, the main staple food crop. However, agriculture is becoming more diversified and commercialized in the Lao PDR. The number of farmers growing non-rice crops in their home gardens and along river banks, especially along the Mekong River or its tributaries, has gradually increased. Some farmers in irrigated areas use part of their rice fields for non-rice crops in the dry season instead of for growing rice. The diversification of crop cultivation has not only improved food security and added nutritional value at the household level, but surpluses are sold in domestic and foreign markets.

Patterns in 2011

Over 100 different kinds of annual crops were grown in the Lao PDR in 2011, broadly falling into the following categories: (a) cereals, (b) stimulants, (c) fiber crops, (d) flowers, (e) fodder crops, (f) leafy and stem vegetables, (g) leguminous crops, (h) oilseed crops, (i) root, bulb and tuberous vegetables, (j) spices, (k) sugar crops, (l) fruit-bearing vegetables, (m) herbs, and (n) others. In reality, the variety of annual crops grown is even greater, as the census only reports data for crops planted on more than 100 m².

The map shows the dominant annual crops (aside from rice) planted in villages throughout the Lao PDR in terms of cultivated area. Fodder cereals, sweet corn and cassava are the most commonly planted annual crops with the largest number of villages growing them as main crop (17 percent, 16 percent and 11 percent of all villages respectively; see Figure 5). Other dominant annual crops popularly grown were chilli (7 percent), Job’s tears (6 percent), cabbage (6 percent), onion (5 percent), sesame (4.5 percent), cucumber and pumpkin (4 percent), sugarcane (3 percent), tobacco (2.5 percent), groundnuts (2.5 percent), watermelon (2 percent) and others (13.5 percent).

Figure 5: Proportion of villages by dominant non-rice annual crop in the village



The majority of Lao farmers feed their livestock with fodder cereals (e.g. maize) and natural pasture grass or with by-product crops (e.g. rice straw). Xiengkhouang is well known for its natural pasture grazing areas for large livestock. Fodder crops were particularly significant in the northern provinces. Xayabouly, Oudomxai, Bokeo and Houaphan are known for their extensive maize production, which is primarily produced as livestock feed. Vietnam, Thailand and China are the main markets for maize produced in these provinces.

Sweet corn is grown for both household consumption and sale. In northern but also in eastern and central Lao PDR, it is predominantly grown for household consumption. However, sweet corn production has grown to a commercial scale in Vientiane Province and Vientiane Capital, surrounding the Lao Agro Industry Company. The company which has a factory in Thoulakhom District, Vientiane Province uses sweet corn to produce sweet corn milk, baby corn and other canned vegetable products for sale in domestic and foreign markets.

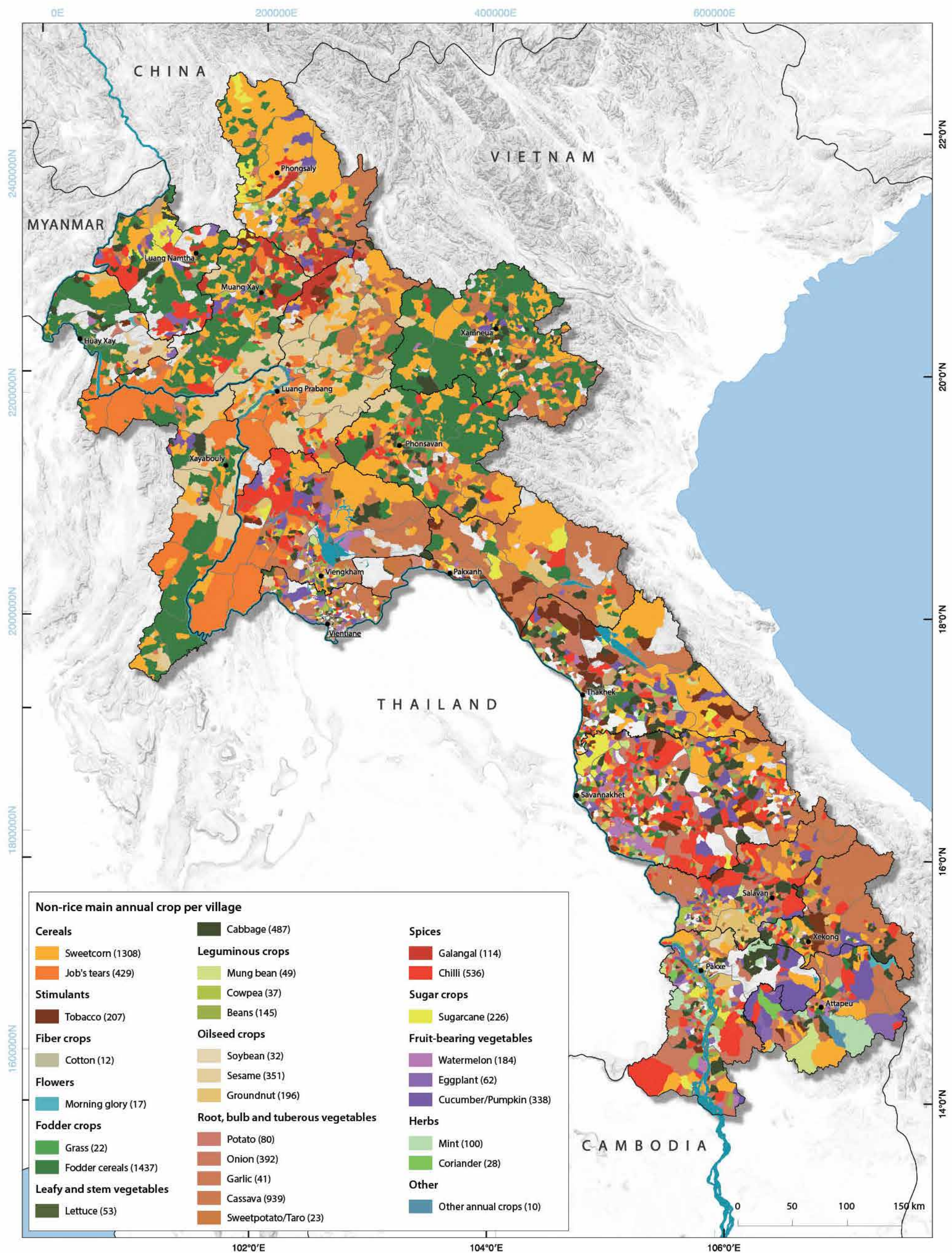
Cassava production has also expanded rapidly. Around 10 percent of agricultural villages (939 villages) throughout the Lao PDR grow cassava as their main annual crop after rice. In recent years, production has reached commercial scales. Due to its proximity to the Lao Indochina Starch Factory, located on the outskirts of Vientiane Capital, cassava has been most extensively planted in Vientiane Capital, Vientiane and Bolikhamxai Provinces. Cassava growers export their products in the form of fresh root or dry chips to neighbouring Thailand and Vietnam.

Over 500 villages grow chilli in their home gardens as their main annual crop for consumption and for sale, but production at a commercial scale is also found in many communities throughout the country. Fresh and dried chilli are mainly exported to Thailand but are also consumed fresh and dried domestically, typically in the form of *jeow* (sauces or pastes), e.g. *jeow bong* Luang Prabang, *jeow Namphak* Salavan or *jeow Pabam* Xamneua.

The map also depicts the cultivation hot spots of Job’s tears in and around Xayabouly (in orange), tobacco in Bolikhamxai and Khammouan (brown), sugarcane in northwest Savannakhet, northern Luang Namtha and western Phongsaly (yellow), galangal in the border areas of Phongsaly, Oudomxai and Luang Prabang (red), and a number of other crop hot spots.

Interpretations

Most of the annual crops grown in the Lao PDR are produced on a small scale and predominantly for household consumption. However, an increasing number of annual crops such as cassava, maize, and sweet corn, and even some varieties of rice, such as “small chicken rice” (*khao gai noy*) are grown at increasing scales to supply expanding international market demand and also to sell to domestic agro-processing factories and markets. Low material inputs, and also the often organic production practices used even for the cultivation of annual crops in the Lao PDR generates special demand in other countries for Lao agricultural products. To further tap into special areas of market demand in the future, Geographical Indicators (GI) are currently under development, e.g. for “small chicken rice” produced by farmers in Xiengkhouang and Houaphan Provinces.



C10 Crop clusters - annual crops

Introduction

In the Lao PDR, around 80 percent of agricultural land is devoted to annual crops. Among the most important annual crops (aside from rice) are: fodder cereals (mainly maize), sweet corn, cassava, sugarcane, soybean, Job's tears, peanut, cowpea, tobacco, galangal, sesame and lemon basil. Annual crops are grown on commercial scales, near markets or close to borders (where transport links often connect to neighbouring country markets) and often in concentrated clusters where many households across an area all cultivate a common crop.

Patterns in 2011

The main map displays the share of the area under selected annual crops to the total annual crop area. A high degree of regional concentration among certain crops, referred to as crop clusters, is apparent. The smaller inset maps portray the cultivation patterns of these key annual cash crop clusters in more detail.

Galangal is a traditional Lao condiment commonly used as ingredient for many Lao dishes as well as in pharmaceutical products. Around 91 percent of the cultivated galangal is concentrated at the joint borders of Phongsaly, Oudomxai and Luang Prabang, and sold to China. Most producing villages use a small percentage of their agricultural land for galangal production, though planting areas range between 25 percent and almost 47 percent in a few villages. In general, however, less than 1 percent of the total agricultural land used for annual crops nationally (excluding rice) is under galangal cultivation.

Sesame cultivation (both black and white varieties) is mostly confined to the northern provinces, particularly Luang Prabang, Oudomxai and Xayabouly. The sesame production area in these three provinces accounts for 84 percent of the country's total area under sesame. Sesame is grown both for local consumption and for export, in particular to China where sesame oil is extracted. Lao farmers usually cultivate sesame by intercropping it with other crops and in home gardens. In general, 4 percent of the agricultural land used for annual crops (excluding rice) is under sesame.

Fodder cereals cultivation (mainly maize) occurs primarily in two major production zones. The first spans Xiengkhouang and Houaphan Provinces and covers around 23 percent of the total fodder cereals cultivation area in the Lao PDR. The second is in Xayabouly, Oudomxai, Bokeo and Luang Prabang Provinces, accounting for 61 percent of the total. Some villages devote up to 96 percent of their agricultural land to fodder cereals cultivation, especially in the south of Xayabouly. But in general, around 40 percent of agricultural land used for annual crops (excluding rice) is under fodder cereals cultivation.

Over 67 percent of the total production area of Job's tears is concentrated in and around Xayabouly Province. Some villages use up to 78 percent of their agricultural land for Job's tears production. Job's tears is grown primarily during the wet season, often as an upland rain-fed crop. In general, 15 percent of the agricultural used land for annual crops (excluding rice) is under Job's tears cultivation.

Peanuts are grown in relatively scattered clusters throughout the Lao PDR, but are predominantly planted in two geographical areas: In Xayabouly Province, home to 21 percent of the total peanut cultivation area in the country, and in the area between Salavan and Champasak Provinces which account for 22 percent of the total area under peanut cultivation. Villages in these two areas can devote up to 38 percent of their agricultural land to peanut production. But in general, only 3 - 4 percent of agricultural land used for annual crops (excluding rice) is under peanut production.

Tobacco is also grown across relatively scattered areas in the Lao PDR, but Bolikhamxai and Khammouan share certainly the biggest cluster with a total of 28 percent of the cultivation area. The majority of villages here use only some percent of their village agricultural land, but some use up to 51 percent of their land for tobacco production. Tobacco is grown essentially in the dry season, often on dry rice fields. In general, 1 - 2 percent of the agricultural land used for annual crops (excluding rice) is under tobacco.

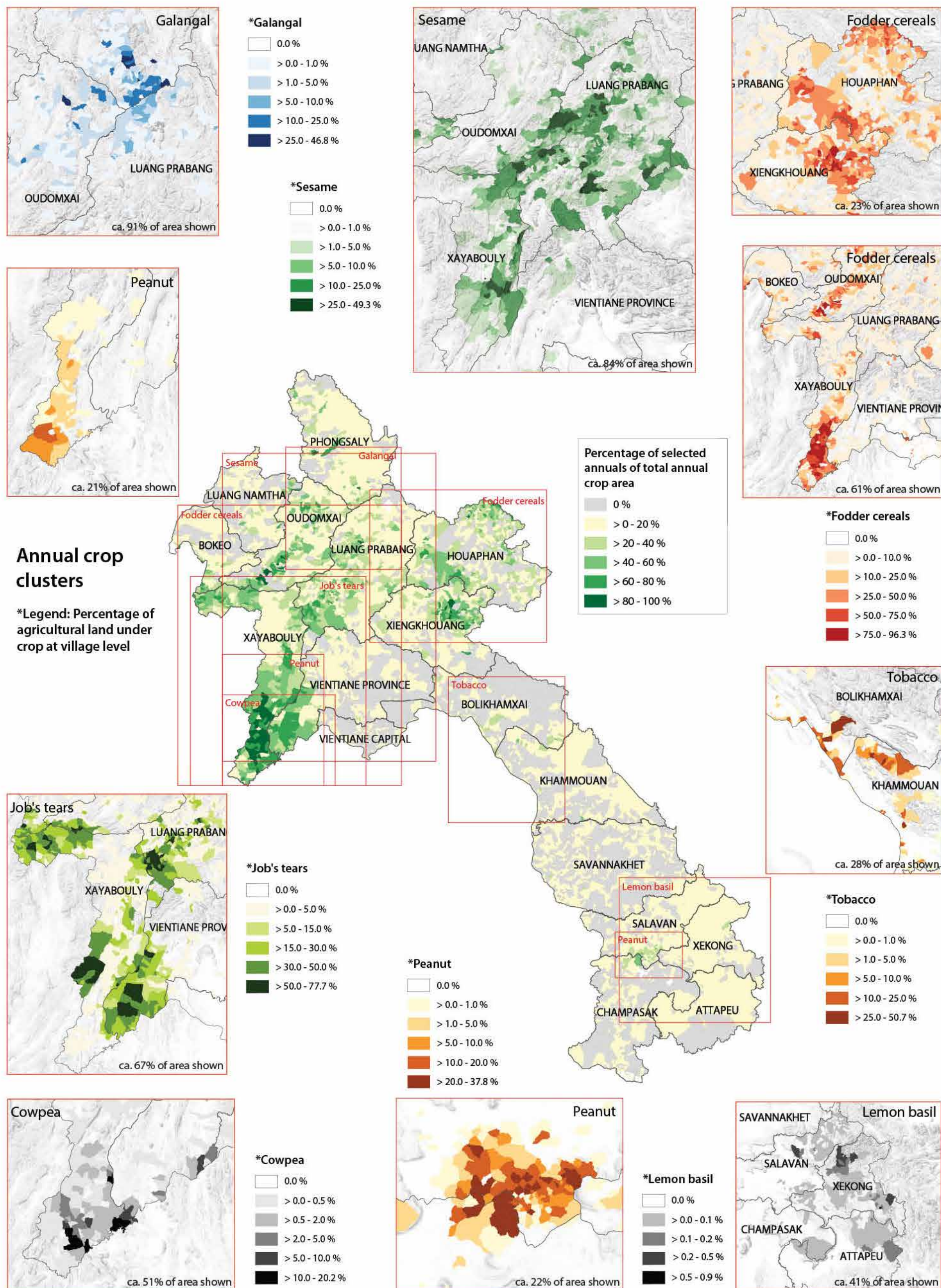
Cowpeas are cultivated mainly in the south of Xayabouly Province, which contains over 50 percent of the total area under cowpea production in the Lao PDR. Farmers usually use a relatively small portion of village agricultural land (under 1 percent of annual crop land, excluding rice area) for cowpea production.

Salavan, Xekong, Champasak and Attapeu together account for 41 percent of the total lemon basil cultivation area in the country. Lemon basil is the most common type of basil used in the Lao PDR and it is a key ingredient for various Lao dishes. In general, under 0.1 percent of the agricultural land used for annual crops (excluding rice) is under lemon basil production.

Interpretations

Annual crop cultivation for commercial purposes (also referred to as annual cash crops) has increased in recent years in the Lao PDR. This reflects a transition currently underway in the country, where agriculture is becoming more commercialized and farmers are growing various crops at larger scales in response to the opening up of markets. An increase was observed in the proportion of farm households producing crops primarily for market instead of for home consumption from around 6 percent in 1999 to 33 percent in 2011 (see B6).

The concentration of commercial production of particular annual crops in certain clusters is largely related to market access, road access and irrigation facilities. Many types of annual crops were densely grown in these clusters in 2011. The highest proportion of farm households growing crops mainly for sale were recorded in the following provinces: Xayabouly (55 percent), Luang Prabang (45 percent), Luang Namtha (40 percent), Champasak (40 percent) and Oudomxai (30 percent).



C11 Maize

Introduction

Maize or corn (*Zea mays*) is an annual cereal crop from Central America that has been cultivated for thousands of years in human history and is used for food, fodder and as a source of oil.

In recent years, more commercialized, market oriented agricultural production has been promoted. Maize is among the country’s priority crops, with high local and international market demand. It is grown mostly for sale as livestock feed, and is sold to buyers in Vietnam, Thailand and China. The production area of maize in the Lao PDR increased significantly within the last decade and it now ranks second after rice in terms of total area under cultivation.

Patterns of maize cultivation in 2011

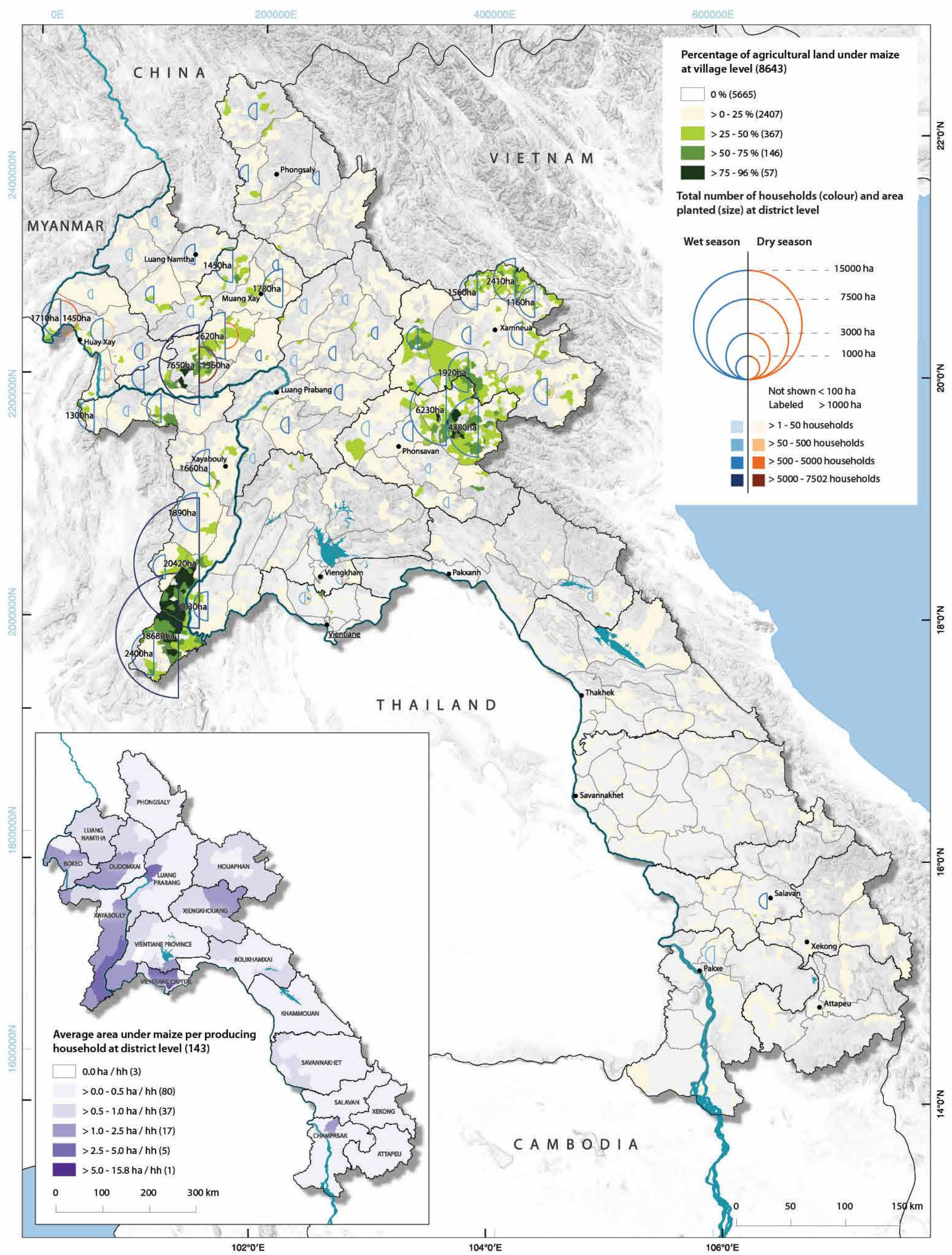
In the Lao PDR, maize is grown mainly on rain-fed fields during the wet season. Of the total area under maize, 93 percent is cultivated during the wet season and 7 percent during the dry season. There is 101,630 ha of maize under cultivation, of which almost half (48,509 ha) was grown in Xayabouly, particularly in Kenthao and Paklai Districts which have 18,680 and 20,420 ha of maize respectively. This region has good delivery systems and market access to Thailand.

Other cluster areas of maize production are the regions between Phonsavan (the provincial capital of Xiengkhouang) and Xamneua (the provincial capital of Houaphan) and in the three districts in the far north of Houaphan. These areas enjoy good access to Vietnam, which is one of the top markets for maize produced in the Lao PDR. In total, there are around 22,000 ha of maize grown in these areas.

As the map shows, there is a third cluster area of significant maize production in Oudomxai and a smaller area in Bokeo. Approximately 22,000 ha are grown in these two areas, of which 5,000 ha is grown during the dry season, which represents 75 percent of all dry season maize production in the Lao PDR.

In total, 2,977 villages in the Lao PDR cultivate maize. Most of them are located in the northern part of the country. While 81 percent of these villages use under 25 percent of their agricultural land for maize, in the above described three cluster regions, many villages use 50 percent or more of their agricultural land for maize cultivation (see C10).

More than 80,000 agricultural households are engaged in maize production on a total area of 101,630 ha, with a countrywide average of almost 1.3 ha per producing household. As the inset map depicts, the average area per producing household in the cluster regions is higher than in other regions in the Lao PDR. The only district with more than 5.0 ha/hh, with an average of 15.8 ha/hh, is Xaisettha District in Vientiane Capital, which is most likely because people who reside in this urban district plant maize in other regions of the country.



Changes in maize cultivation patterns between 1999 and 2011

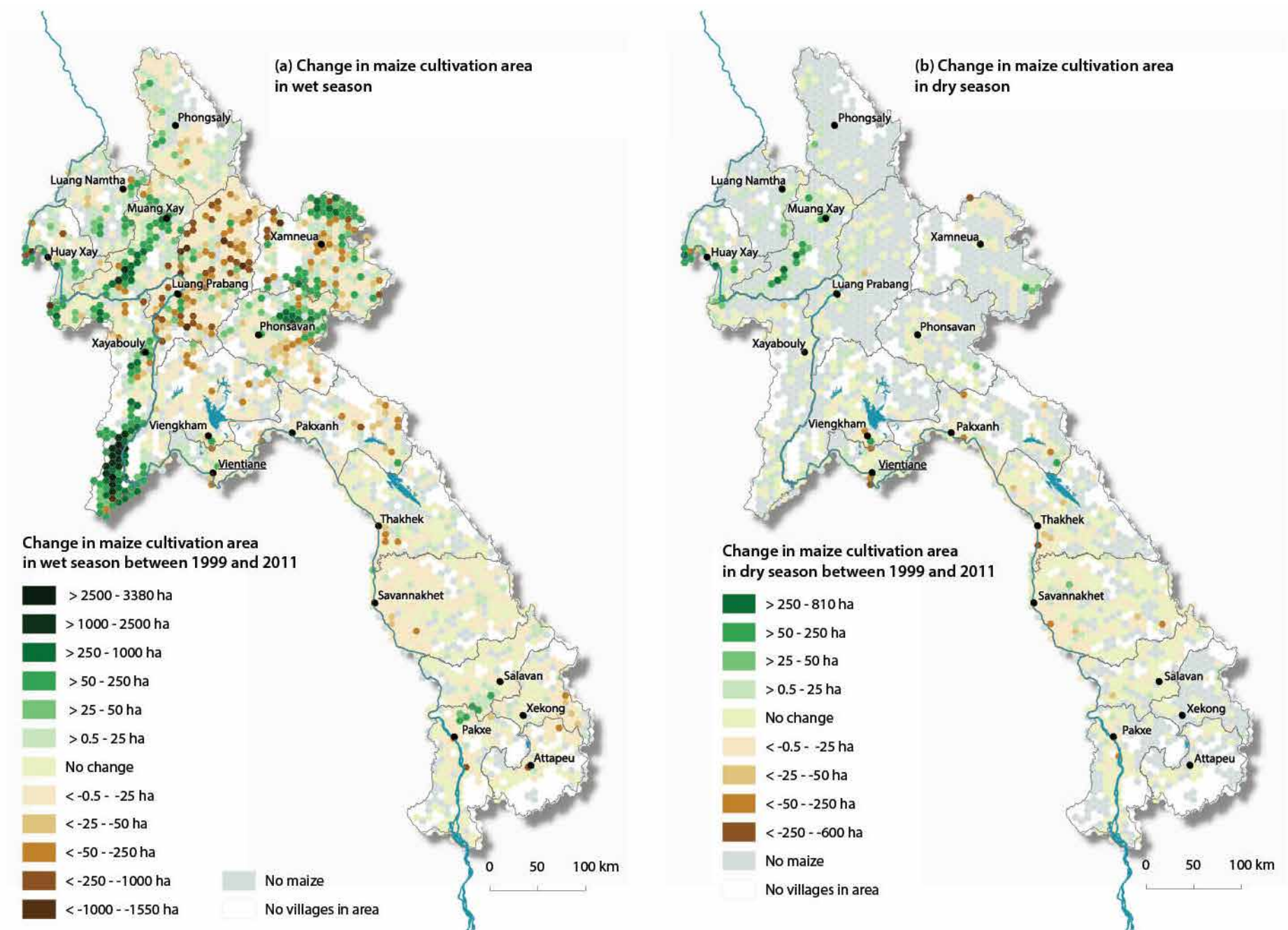
The spatial pattern of maize planting has clearly changed, primarily in terms of wet season cultivation. The total area under maize production in the Lao PDR now is over 20 percent greater than it was in 1999 (78,850 ha).

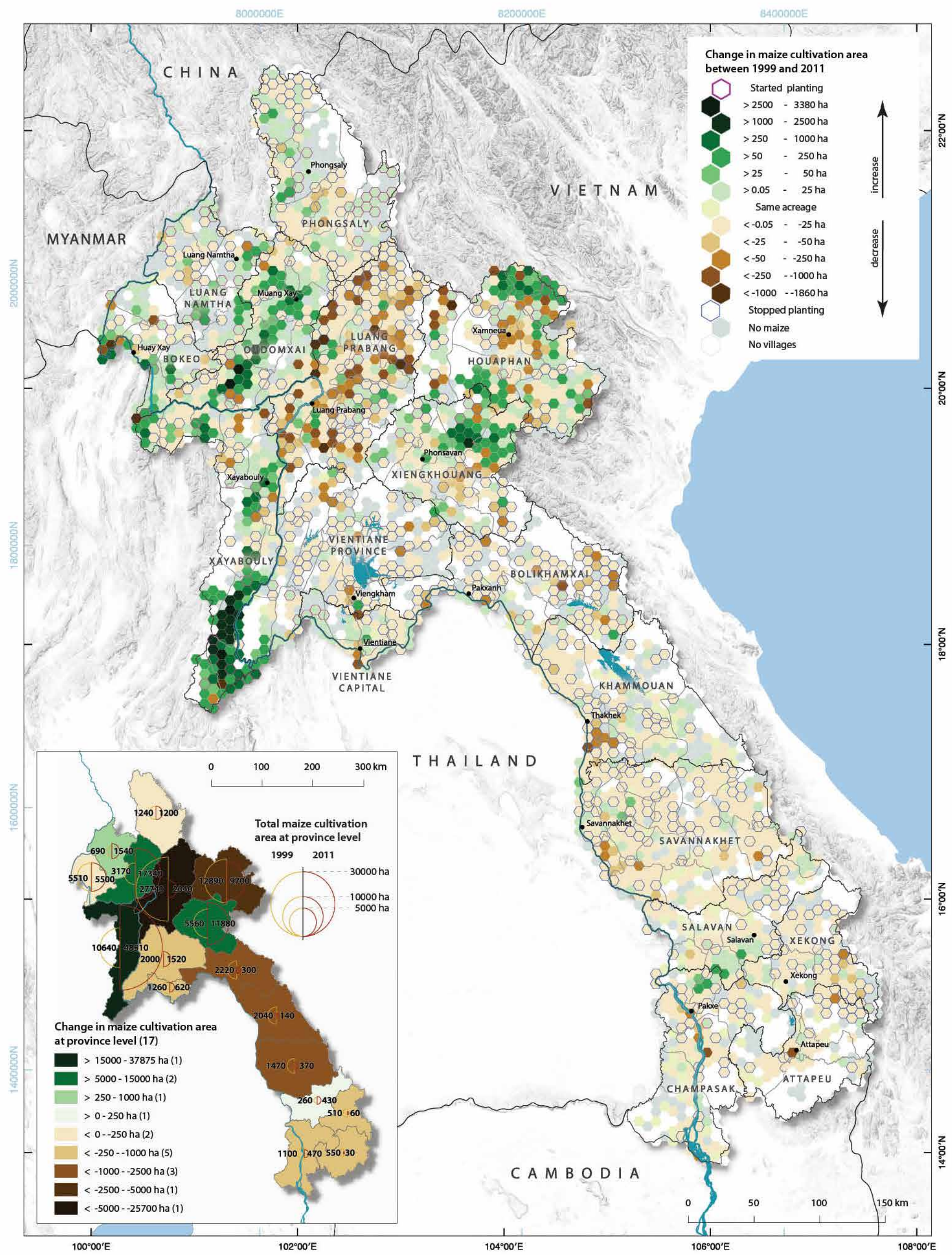
In Luang Prabang Province, the area under maize declined from 27,740 ha in 1999 to only 2,040 ha in 2011, a decrease of 93 percent. Maize cultivation has also declined in central Houaphan, southeastern Xiengkhouang, eastern Bolikhamxai and in almost all regions in southern Lao PDR. Increases in maize production were thus limited to southern Xayabouly, northeastern Xiengkhouang, northern Houaphan and central Oudomxai.

Interpretations

Maize has become one of the main cash crops in northern Lao PDR in recent years. The main drivers for maize expansion are the high demand from neighbouring countries, especially Thailand, Vietnam and China, where rapid economic and demographic growth coupled with higher meat consumption have generated increases in livestock raising and therefore high demand for industrial feed (Newby, 2016). Seeing benefits in terms of rising prices, smallholder farmers along the borders with these three countries have expanded maize production areas rapidly and extensively.

Another important driver contributing to the growth in maize production in the Lao PDR is the Thai government’s tax exemption policy under the Ayeyawadi-Chao Phraya – Mekong Economic Cooperation Strategy. This strategy, established in 2003, has made it easier to export maize to Thailand. A further factor is the provision of credit for purchasing seeds and fertilizers (the main inputs in maize production) to Lao farmers by Thai investors in Xayabouly, Chinese investors in Oudomxai, and Vietnamese in Houaphan. Finally, the establishment of post-harvesting processing facilities (dryers) around Oudomxai is an additional factor encouraging maize production.





C12 Job's tears

Introduction

Job's tears (*Coix lacryma-jobi* L.) is a relative of maize in the "Maydae" tribe of the grass family, and is commonly called Job's tears or croix seed (Chaisiricharoenkul *et al.*, 2011). It is mainly planted in East and Southeast Asia, including in Japan, China, the Philippines, Myanmar, the Lao PDR and Thailand. Job's tears is a cereal grain containing more nutritious fat and protein than wheat or rice, and is also used in traditional medicine in China and in health foods and drinks (Burnette, 2012).

In the Lao PDR, Job's tears is a traditional crop, cultivated by certain ethnic groups, particularly Khmu and Hmong, for household consumption and animal feed. In periods of rice shortage, Job's tears becomes a supplement carbohydrate for Lao producers. Most commonly, people plant Job's tears in upland rain-fed fields together with upland rice, sesame and various other upland crops, though it is also grown in lowland areas such as along the Mekong River. Job's tears is grown as both a subsistence and a cash crop, though compared to cassava (see C13) or maize (see C11), Job's tears is not a high preference crop for commercial production.

Patterns of Job's tears cultivation in 2011

In 2011, there were in total 37,812 ha of Job's tears planted in the Lao PDR, primarily in western Vientiane Province (14,884 ha), Xayabouly (12,799 ha), southwest Luang Prabang (7,303 ha), southwest Oudomxai (1,590 ha) and southern Bokeo (1,084 ha). However, 7,423 villages (86 percent) do not cultivate Job's tears, whereas 1,220 villages (14 percent) cultivate at least some Job's tears. Finally, there are a few places where villages focus on Job's tears (181 nationally) which plant 30 - 78 percent of their agricultural land with the crop.

Job's tears is generally a wet season crop, and Xanakham District, Vientiane Province has the largest area planted with 10,310 ha in the

wet season. In Vientiane Province, Job's tears occupy 11 percent of the total agricultural land, 8 percent in Xayabouly and 6 percent in Luang Prabang. Table 2 gives detailed information about the total area and percentage of Job's tears in the wet, the dry and over both seasons in 2010/11 per province.

The small inset map shows the average household area of Job's tears at district level. The highest average area per producing household is 6 ha in Thoulakhom District, Vientiane Province. In all other districts, an average maximum of 2 ha per household are grown. In total, 38,964 households are engaged in Job's tears production of which over one third are in Xayabouly (14,045 households), around one quarter are in Luang Prabang (10,063 households) and another quarter are in Vientiane Province (9,909 households).

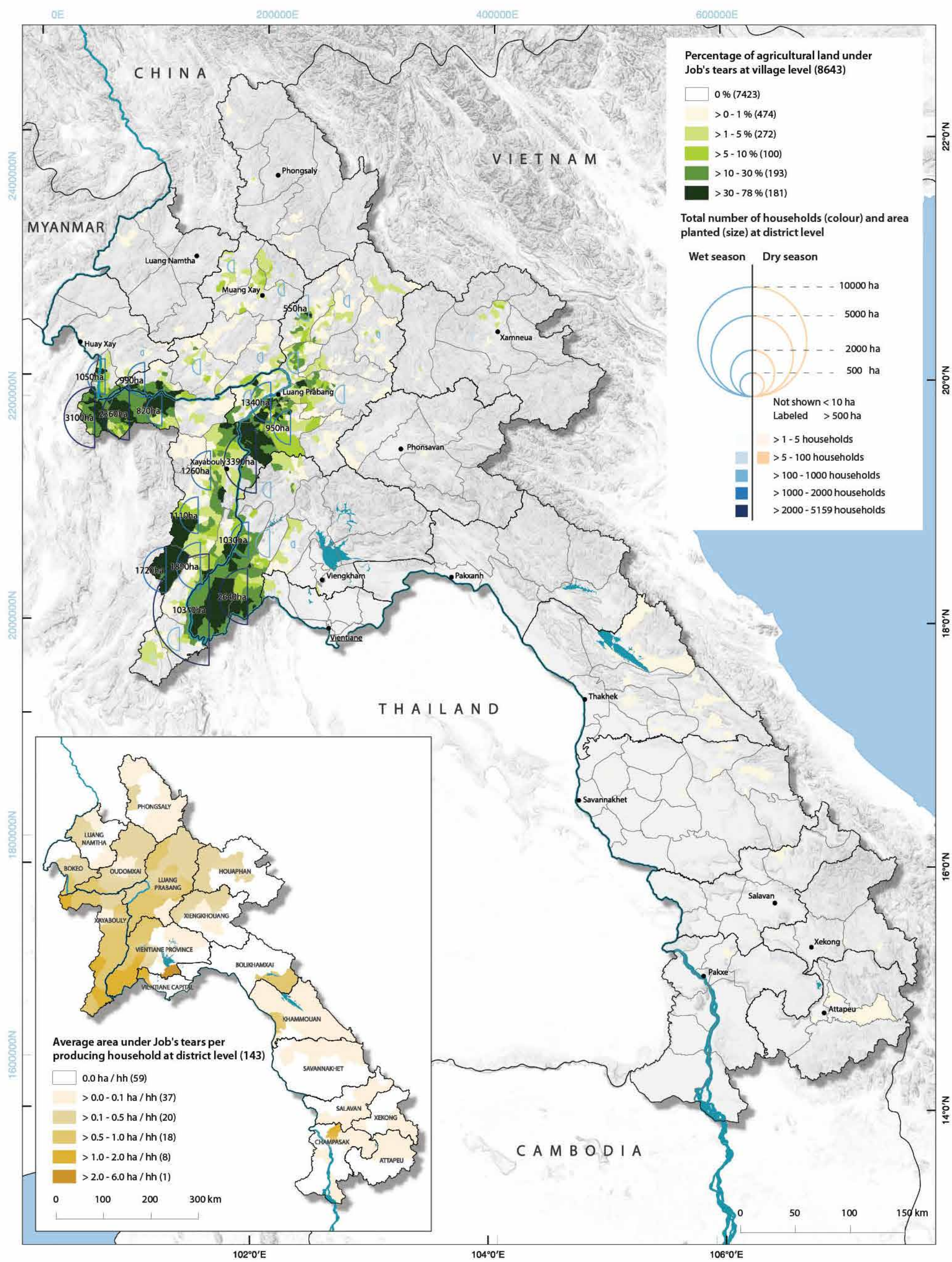
Potential and limitation for Job's tears production

Job's tears is highly adaptive to poor soil conditions, though animal manure is used to improve yields in some places. In addition, Job's tears requires low labour inputs, especially compared to rice production, as it requires weeding only once or twice after planting. The yield per hectare of Job's tears is 57 percent higher than that of upland rice and the harvest period is shorter (Rouw *et al.*, 2002).

Market demand for Job's tears comes primarily from China, Taiwan and also Thailand (Burnette, 2012). However, demand for Job's tears is developing slowly compared to the demand for maize (see C11), cassava (see C13) and other cash crops. The frequent fluctuation in market value of Job's tears generates insecurity for Lao farmers planting the crop. Aside from market access, fluctuating market values and market constraints are key obstacles for agricultural development in the Lao PDR. Additionally, Job's tears is not one of the Ministry of Agriculture and Forestry's priority agricultural commodities, so the cultivation of Job's tears is not explicitly promoted and therefore remains limited to certain regions.

Table 2: Area and percentage of Job's tears in the wet, the dry and over both seasons in 2010/11 per province

Province	Total ha Job's tears 2010 wet season	Job's tears cultivated in 2010 wet season (% of total)	Total ha Job's tears 2011 dry season	Job's tears cultivated in 2011 dry season (% of total)	Total ha Job's tears 2010/11 both season	Percentage Job's tears 2010/11 both season
Vientiane Capital	113.9	100.0	0.0	0.0	113.9	0.3
Phongsaly	3.1	100.0	0.0	0.0	3.1	0.0
Luang Namtha	1.3	99.6	0.0	0.4	1.3	0.0
Oudomxai	1,575.3	99.0	15.1	1.0	1,590.4	4.2
Bokeo	1,081.0	99.7	3.0	0.3	1,084.0	2.9
Luang Prabang	7,296.5	99.9	7.0	0.1	7,303.5	19.3
Houaphan	25.5	100.0	0.0	0.0	25.5	0.1
Xayabouly	12,798.2	100.0	0.7	0.0	12,798.9	33.8
Xiengkhouang	1.8	85.7	0.3	14.3	2.1	0.0
Vientiane	14,876.8	99.9	7.5	0.1	14,884.3	39.4
Bolikhamxai	0.0	0.0	0.6	100.0	0.6	0.0
Khammouan	1.7	99.4	0.0	0.6	1.7	0.0
Savannakhet	0.5	99.0	0.0	1.0	0.5	0.0
Salavan	0.0	66.7	0.0	33.3	0.1	0.0
Xekong	0.0	66.7	0.0	33.3	0.0	0.0
Champasak	2.0	98.5	0.0	1.5	2.0	0.0
Attapeu	0.0	55.6	0.0	44.4	0.0	0.0
Total	37,777.8	99.9	34.3	0.1	37,812.1	100.0



C13 Cassava

Introduction

Cassava (*Manihot esculenta*) starch is the most widely traded of all native starches worldwide and has a diversity of functions which make it a key input for a range of both food and non-food products. Cassava starch is used in many products including paper, pharmaceuticals, textiles, bioplastics and pet food. In addition to the uses of cassava starch, dried cassava chips are used as livestock feed and as a feedstock for ethanol production. Cassava starch is derived from cassava roots grown by many smallholder farmers in Southeast Asia. Finally, cassava remains an important food crop for some upland communities in Southeast Asia. With its combined applications, demand for cassava is likely to increase in the future.

In recent years, cassava has been promoted as a commercial crop by traders coming to the Lao PDR from neighbouring countries. Cassava is a tuber root crop and it ranks third after rice and maize in terms of the total area under cultivation nationally (FAO, 2014).

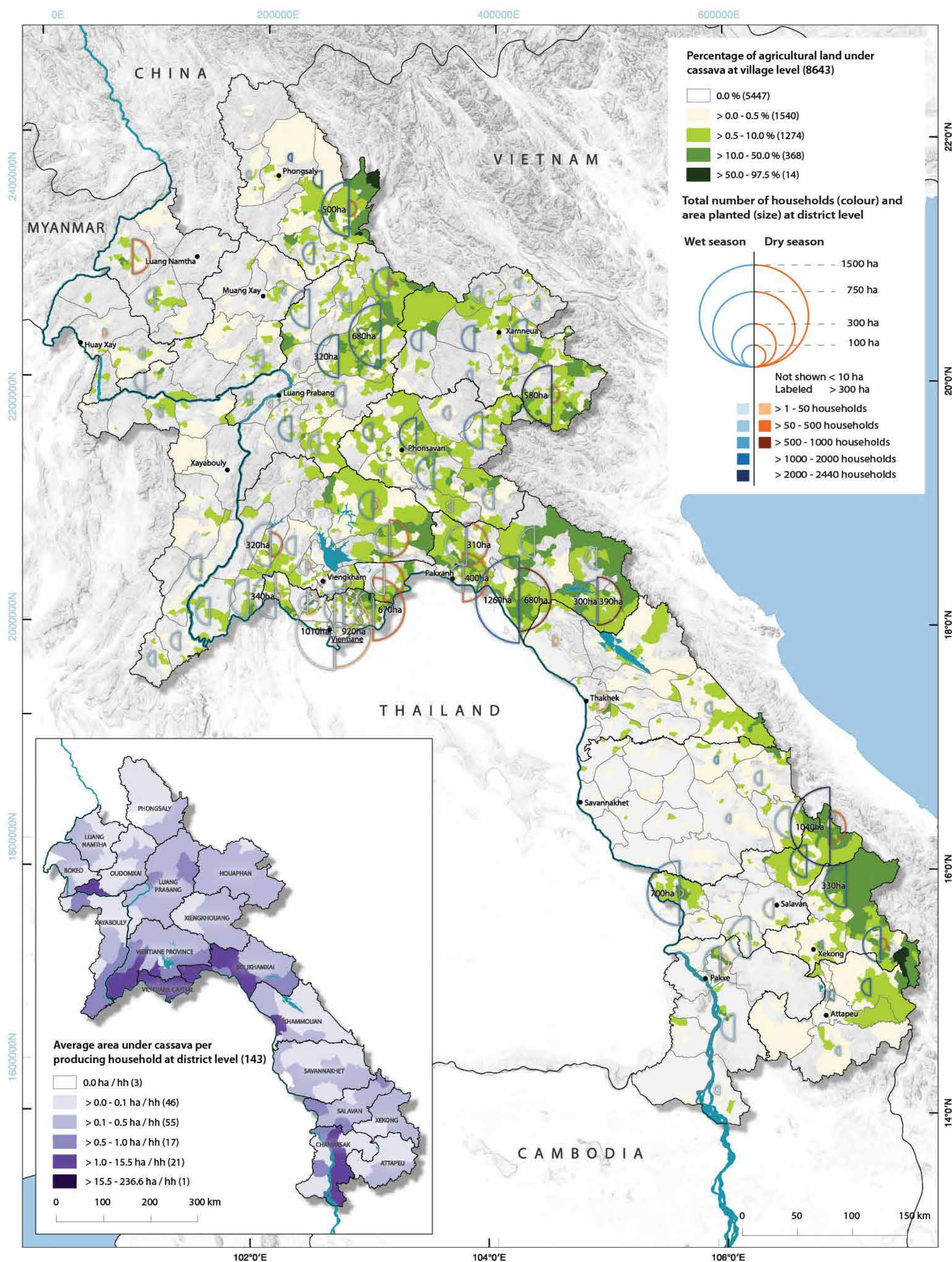
Patterns of cassava cultivation in 2011

Cassava is, with 18,950 ha, a widely grown cash and food crop in the Lao PDR. A total of 3,196 villages (37 percent of all villages) grow cassava nationally, though most on a relatively small amount of their total agricultural land. 2,814 or 88 percent of producing villages use less than 10 percent of their agricultural land for cassava. Most of the 382 villages (the other 12 percent of producing villages) which devote a larger portion of their land to cassava are located along the eastern border with Vietnam.

Cassava is grown in both the wet and dry season, though 73 percent of the area under cassava is grown in the wet season and only 27 percent is grown in the dry season. The districts with cassava cultivation in the dry season are predominantly located alongside the Mekong River, from Vientiane Capital to Bolikhamxai. In Vientiane Capital, as the only of all 17 provinces, the area devoted to cassava cultivation is in the dry season greater than in the wet season, with 1,949 and 1,895 ha respectively.

In Vientiane Capital, there are 3,844 ha planted by only 896 households (an average of 4.2 ha per producing household), thus there are far fewer households involved in cassava production than in other provinces. In Savannakhet Province, in contrast, only 232 ha are grown by 1,760 households making the average only 0.1 ha per household. In Bolikhamxai, where 23 percent (4,377 ha) of the total cassava area of the entire country is planted, the average area per household is 0.84 ha.

As is also observed in other crops like peanut or sugarcane (see C14 and C16), the average area per producing household in Phongsaly Province is lower than in other provinces. A small area of cassava (700 ha) is cultivated in Phongsaly, but the total number of households growing cassava in both the wet and dry season is 5,339 which is very high in comparison to other provinces.



Changes in cassava cultivation patterns between 1999 and 2011

The total area devoted to cassava decreased from 24,800 ha to 18,950 ha between 1999 and 2011. Houaphan Province experienced the most significant decline, as cassava has been widely replaced by maize production (see C11). This was largely pushed by huge market demand for maize from Vietnam. Vietnamese traders provide credit to farmers for purchasing maize seeds and other inputs and make deductions when buying back harvests. Therefore, it is not surprising that the area under cassava declined 90 percent in Houaphan from 11,120 ha in 1999 to 1,120 ha in 2011.

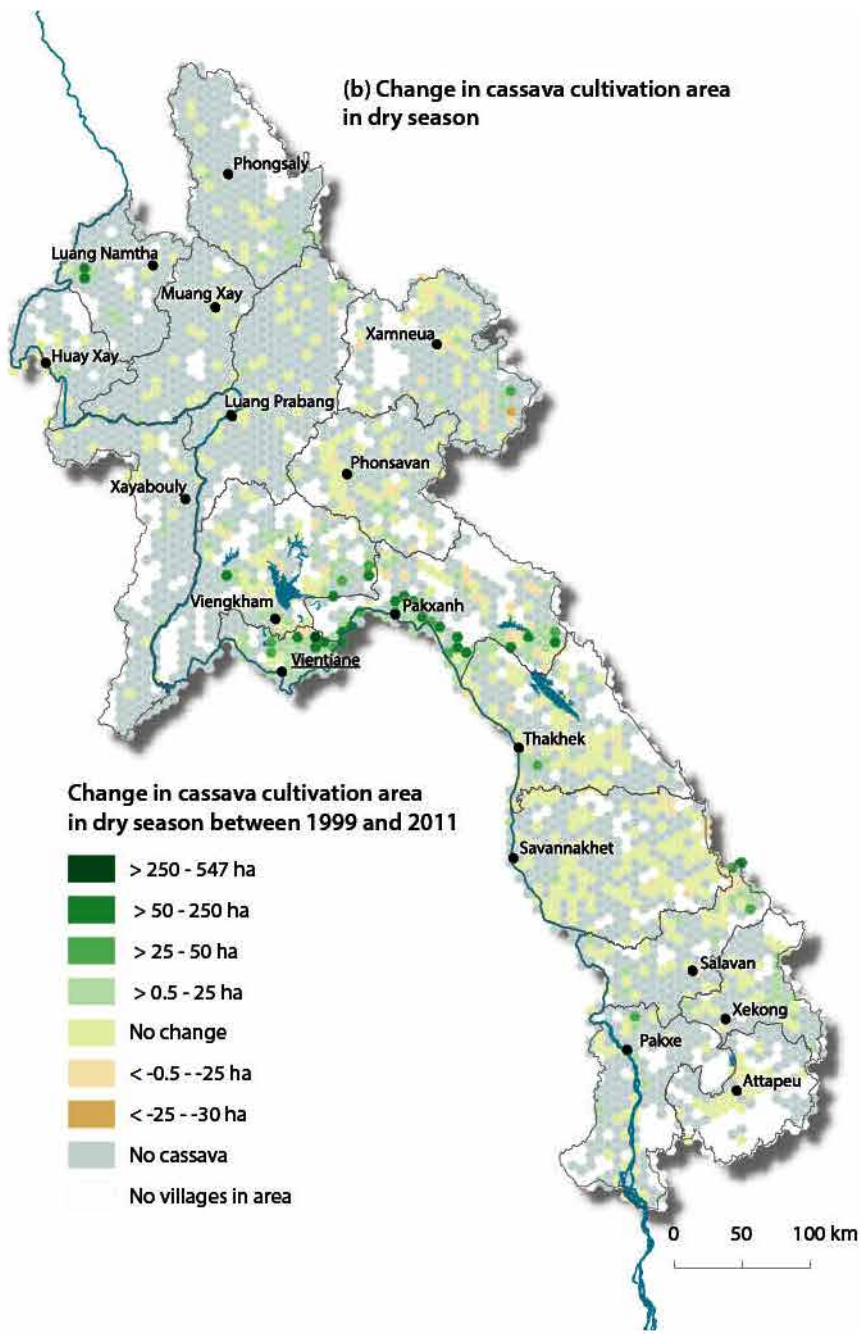
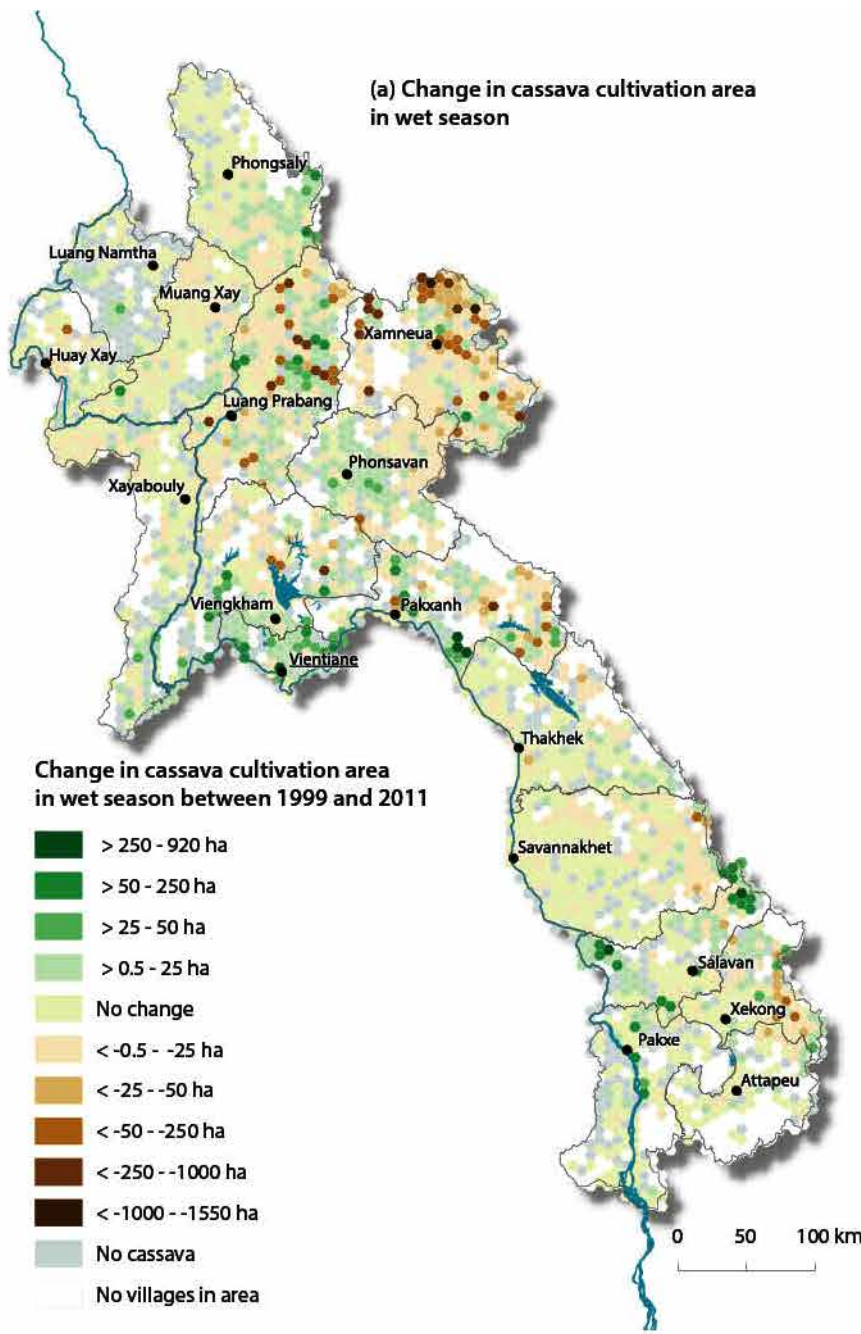
Similar trends are also found in Luang Prabang and Xekong Provinces, but not so drastically as in Houaphan. In Luang Prabang, the area under cassava decreased from 6,230 ha in 1999 to 1,800 ha in 2011. During the same period, around half of the previous cassava production area was left uncultivated in Xekong Province, while other cassava cultivation areas were replaced with coffee (see C21).

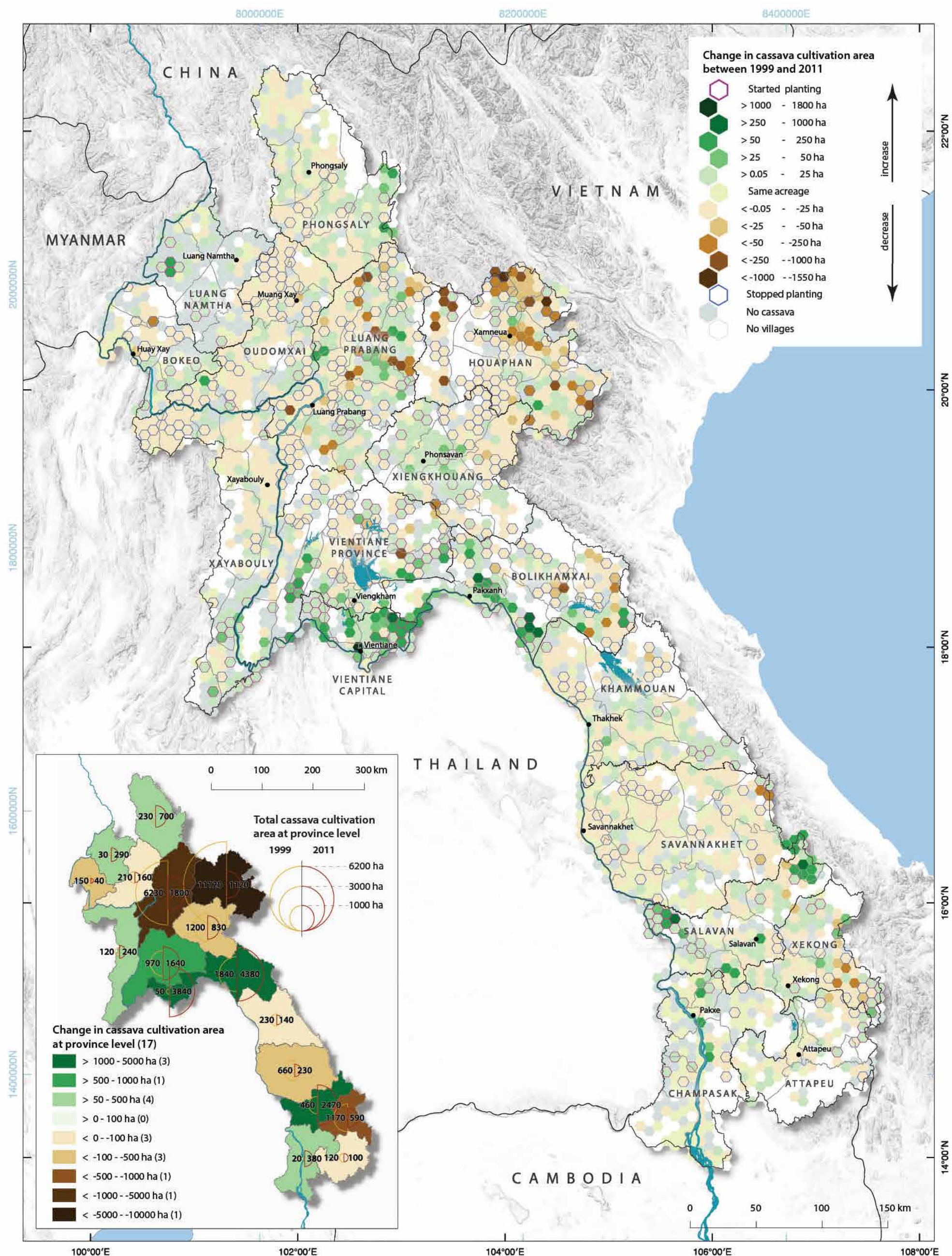
In contrast, in other provinces where market demand is stronger, the area under cassava increased rapidly. This includes Vientiane Capital, Bolikhamxai and Salavan. In Vientiane Capital, the cassava area increased from 50 ha in 1999 to 3,844 ha in 2011; from 1,840 ha to 4,380 ha in Bolikhamxai Province, and from 460 ha to 2,470 ha in Salavan Province during the same period.

Interpretations

Cassava produced in Vientiane Capital, Vientiane Province and Bolikhamxai is mainly sold to the Lao Indochina starch factory located in the suburbs of Vientiane Capital. Other provinces export dry chips to Thailand and Vietnam. The key push factors for cassava production in the Lao PDR are market demand related: high prices offered by Chinese, Thai and Vietnamese markets, and the increase in dry starch factories in the country requiring dry cassava chips, which are used in feed production. The largest feed mill in the country is CP Laos, a subsidiary of CP Thailand, which is the largest producer of animal feed in Asia. CP took over the Ban Thangon Feed Mill in 2009. The mill needed more than 4,000 tons of dried chips annually to run the factory at full capacity, but it was reported that the factory confronted difficulties obtaining sufficient cassava chips in 2011.

Instability in the cassava market in the past decade has created concerns and impacted smallholders' livelihoods in the Lao PDR and in many countries in Southeast Asia. One of the key factors affecting the cassava production chain was a set of protective policies launched in many neighbouring countries in the past years to protect their own farmers, e.g. price supports in China and quarantine or quality controls by Thai government. These led to drops in demand for intermediate cassava products and led to declining cassava root prices. Finally, farmers in the Lao PDR have suffered from low farm gate prices caused by high transportation costs.





C14 Peanut

Introduction

Peanut (*Arachis hypogaea*), also known as the groundnut, is a legume and belongs to the Papilionaceae family. Peanuts are widely grown in the tropics and subtropics for local consumption and commercial production. The global production of peanuts in 2011 totalled 35.9 million tons, of which China produced 45 percent and India produced 16 percent.

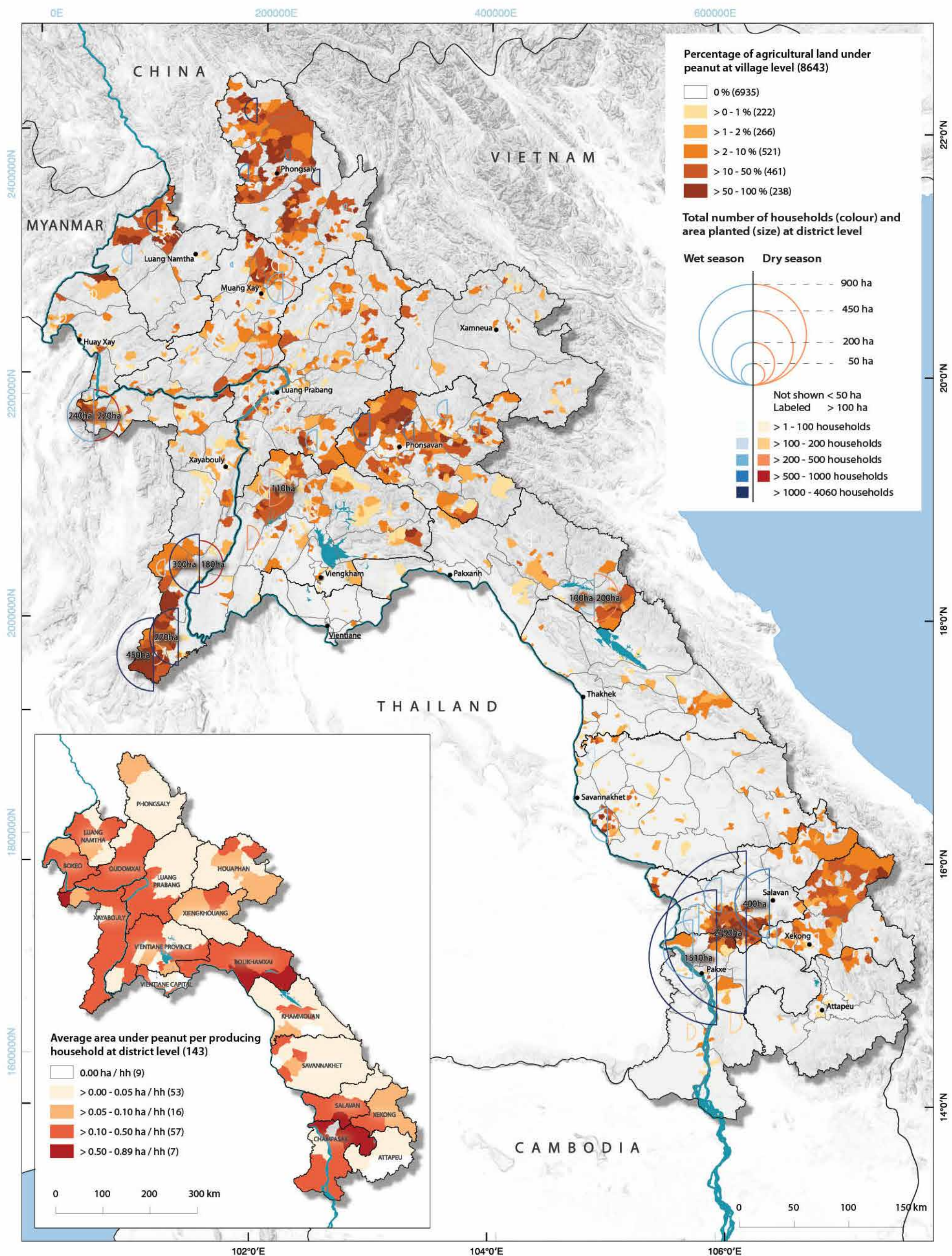
Peanuts are used both for direct consumption in food and snacks and are processed into peanut oil. The production of peanuts in the Lao PDR is mostly for household consumption and for sale to local markets on a relatively small scale. Many farmers grow local varieties of peanuts which are of relatively low productivity compared to newly introduced hybrid peanut seeds. These are sold in local markets throughout the country, often in small quantities, and are sold fresh, ground, dried, and shelled, without quality control. Peanuts grown for export are sold to markets in China, Vietnam and Thailand.

Patterns of peanut cultivation in 2011

Peanut cultivation in the Lao PDR is spread across 1,708 villages (20 percent of all agricultural villages), and is engaged in by more than 30,000 households. Only 238 villages (3 percent) use more than 50 percent of their agricultural land for peanut production, while 461 villages (5 percent) devote 10 - 50 percent of their agricultural land to peanut cultivation. A total of 8,300 ha is planted, of which more than half is located in the south in Salavan, Xekong, Champasak and Attapeu Provinces. In the north, peanut cultivation accounts for 2,552 ha, and very little is planted in central Lao PDR (984 ha).

Peanut production is often concentrated in clusters. Laongam and Bachiangchaleunsouk Districts, located in the north of the Bolaven Plateau between Pakxe and Salavan town, stand out for peanut production. They have 2,190 ha and 1,510 ha of peanuts planted in the two districts respectively, which accounts for nearly half of the total production area in 2011. Another cluster of peanut planting is in southern Xayabouly Province near the Thai border. In this area, more than 1,000 ha of land is under peanut production across three districts (namely in Boten, Kenthao and Paklai), mostly planted during the wet season (see C10). Peanut production in Xiengkhouang Province is also notable, especially in Phoukout District, west of the province capital Phonsavan, where many villages use considerable portions of their agricultural land for peanut production.

The small inset map depicts the average area per household under peanut cultivation at district level. In southern Salavan, northern Champasak, and southern Bolikhamxai, the average household area is between 0.50 and 0.89 ha. Interestingly, production in Phongsaly Province only constitutes 1 - 2 percent of the total production area of peanuts in the Lao PDR, but 15 percent of households in Phongsaly are involved in peanut cultivation (see C13, C16 and C17).



Changes in peanut cultivation patterns between 1999 and 2011

The total peanut cultivation area declined by more than 7,600 ha (92 percent) between 1999 and 2011 from 15,973 ha to 8,300 ha. Production dropped in both seasons from 10,542 ha to 6,942 ha in the wet season and from 5,433 ha to 4,075 ha in the dry season. Luang Prabang and Xayabouly Provinces experienced a marked decline in the agricultural land under peanut production of 5,837 ha and 2,969 ha respectively.

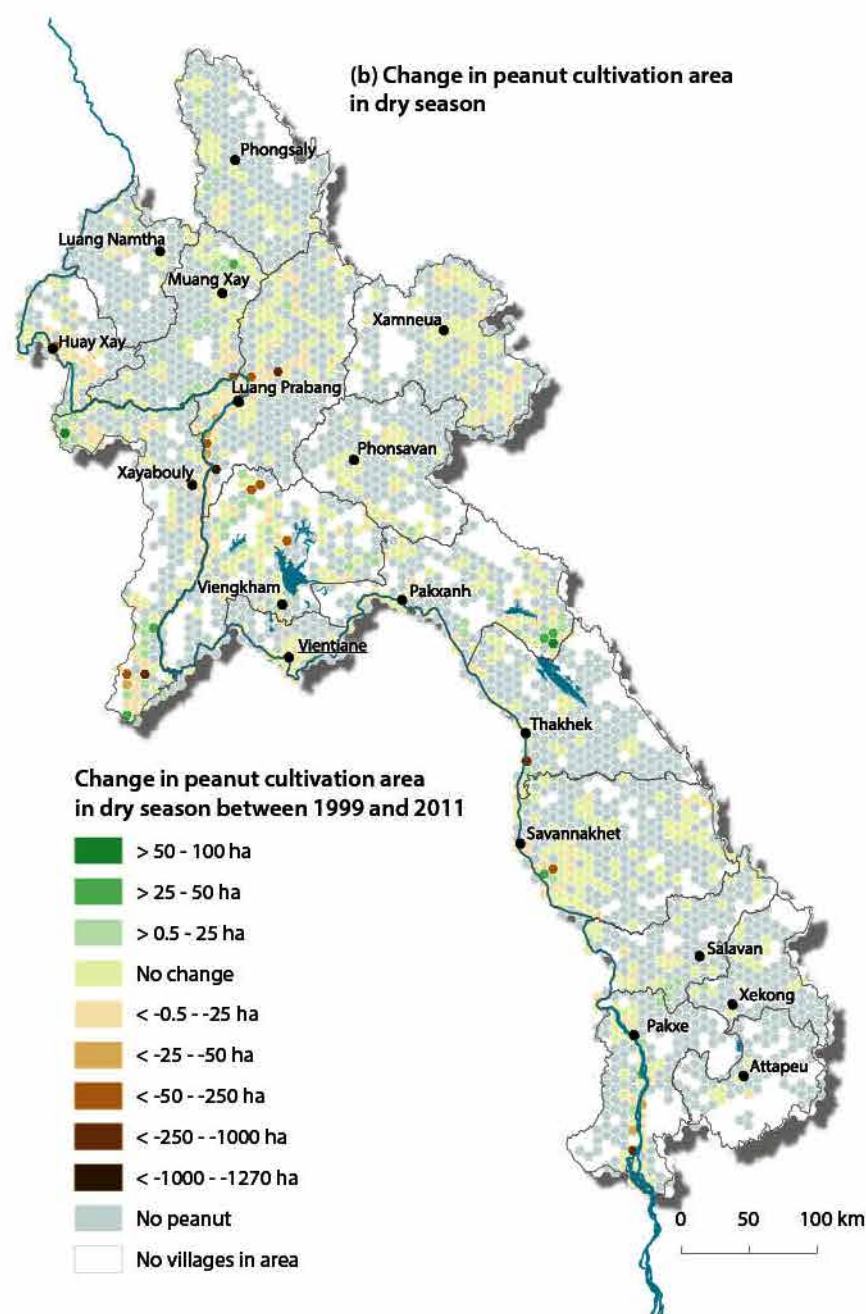
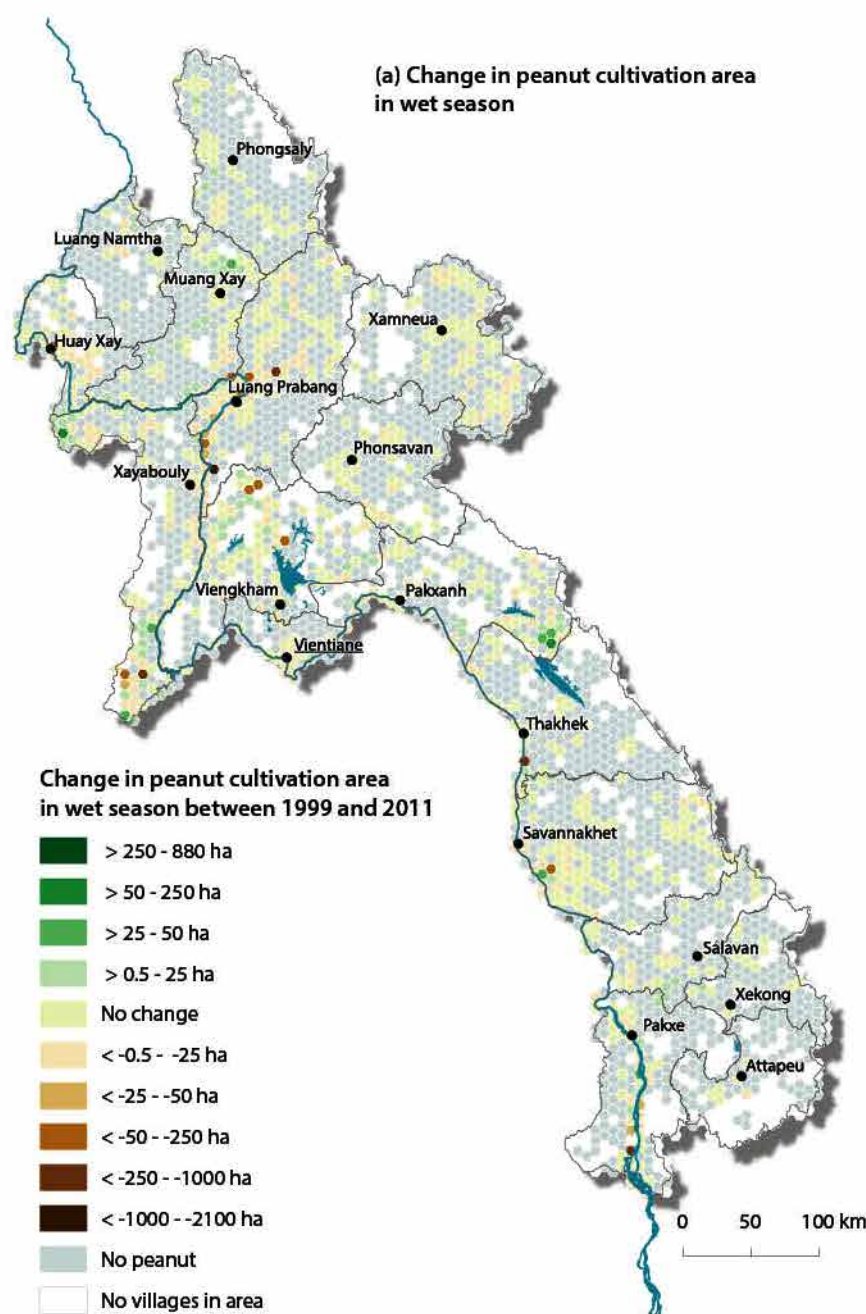
The main map further reveals that, in west and southwest Luang Prabang Province and in southern Xayabouly Province, the area dedicated to peanut declined significantly. In contrast, the region north of the Bolaven Plateau increased its peanut cultivation area. Also in Khamkeut District in Bolikhamxai Province, peanut production increased from 100 ha in 1999 to more than 300 ha in 2011 of which 200 ha are grown during the dry season. In other regions of the country, change was not as significant.

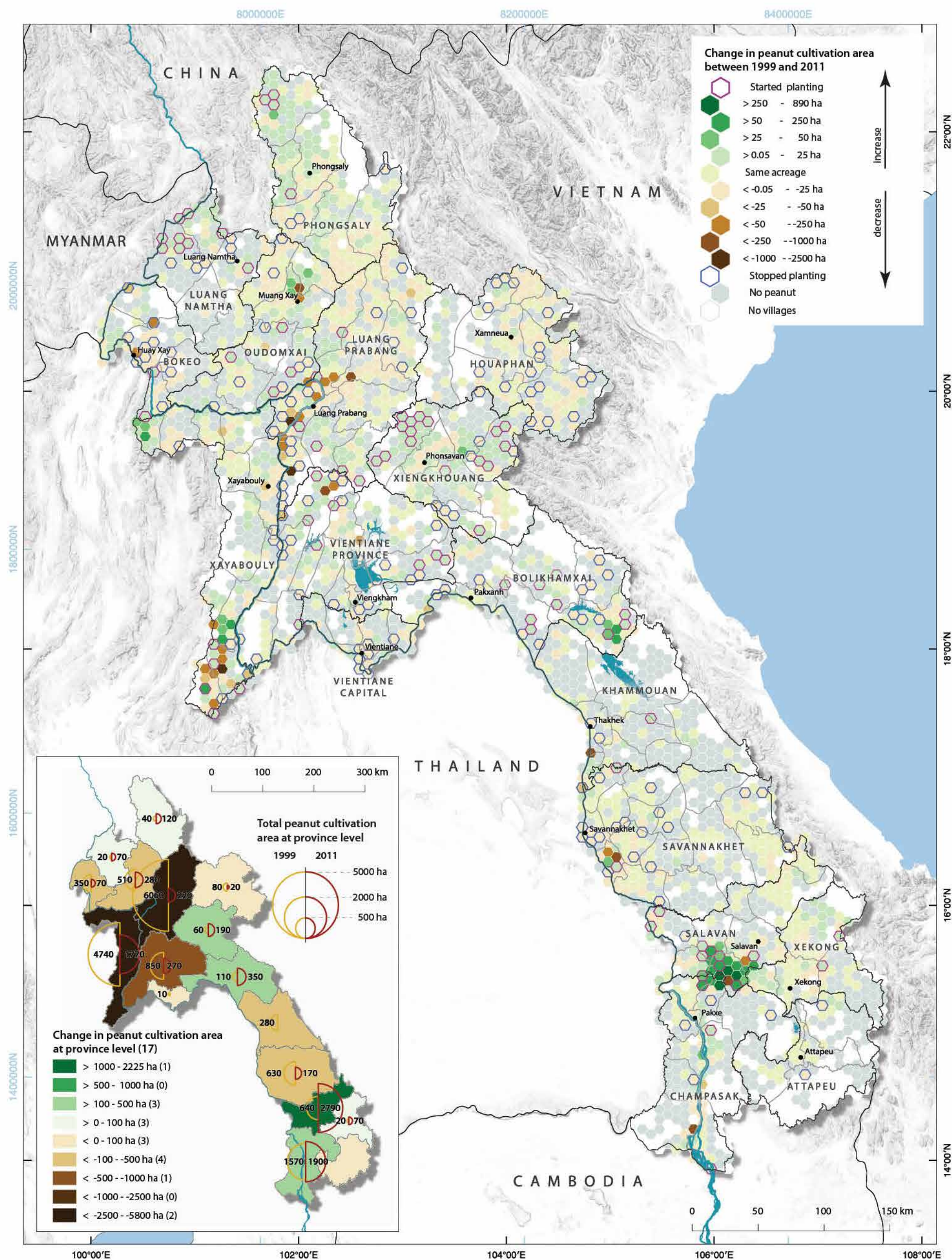
Although the area under peanut production between 1999 and 2011 declined significantly overall, the number of households engaged in peanut production in the wet season increased slightly. 23,981 households were engaged in 1999 and 24,084 in 2011. In the dry season, however, the number of households growing peanuts declined significantly from 10,233 to 5,963 households.

Interpretations

There are several factors contributing to the decline in peanut cultivation area in the Lao PDR between 1999 and 2011. First, Luang Prabang authorities were overly ambitious in using peanut promotion as an alternative to shifting cultivation within their shifting cultivation eradication campaign. Large areas of peanut were established without proper studies of soil suitability and market access for peanuts. Once farmers realized that peanut was not an optimal choice for income generation, they looked for other crops with more stable markets and higher market values.

Second, Chinese and Vietnamese peanuts, introduced recently to the Lao market, have out competed Lao peanuts which are sold at lower prices and in higher quantities. Lao farmers' varying levels of skill and experience in peanut production also play a crucial role in the scale and success of production in many areas. For instance, in the region between Pakxe and Salavan town, peanut production has a long history. With relatively good infrastructure, high soil quality, and close proximity to markets, the conditions for production are better there than in the northern and central provinces.





C15 Soybean

Introduction

The soybean (*Glycine max* L.) is an Asian legume, widely grown for direct human consumption but which can also be processed into a range of other products. It contains essential high proteins for humans and animals and the by-product from soybean oil production, the soybean cake, also contains protein with a high energy and amino acid profile. Soybeans have been grown and consumed in China for more than 5,000 years. Today, soybeans are often produced at large scales in monoculture plantations, mostly in North and South America.

Some Asian countries have a long history of planting soybeans, but in the Lao PDR, soybean cultivation was introduced only recently. Soybean cultivation can be a source of income for local people, who are gradually shifting from traditional production systems aimed at meeting household consumption needs to a more market oriented economy.

Table 3: Total and change of area of soybean between 1999 and 2011

Province	Total ha soybean 1999	Total ha soybean 2011	Change 1999 to 2011
Vientiane Capital	8.2	2.8	-5.4
Phongsaly	1,691.2	148.6	-1,542.6
Luang Namtha	9.2	21.0	11.8
Oudomxai	166.0	468.8	302.8
Bokeo	192.3	35.5	-156.8
Luang Prabang	974.7	417.6	-557.1
Houaphan	3,662.7	190.8	-3,471.9
Xayabouly	59.1	4.3	-54.8
Xiengkhouang	342.3	49.7	-292.6
Vientiane	67.3	2.9	-64.4
Bolikhamxai	13.8	0.9	-12.9
Khammouan	0.0	0.0	0.0
Savannakhet	9.1	0.9	-8.2
Salavan	331.5	122.3	-209.2
Xekong	9.0	0.0	-9.0
Champasak	728.0	439.8	-288.2
Attapeu	24.7	0.0	-24.7
Total	8,289.0	1,906.0	-6,383.0

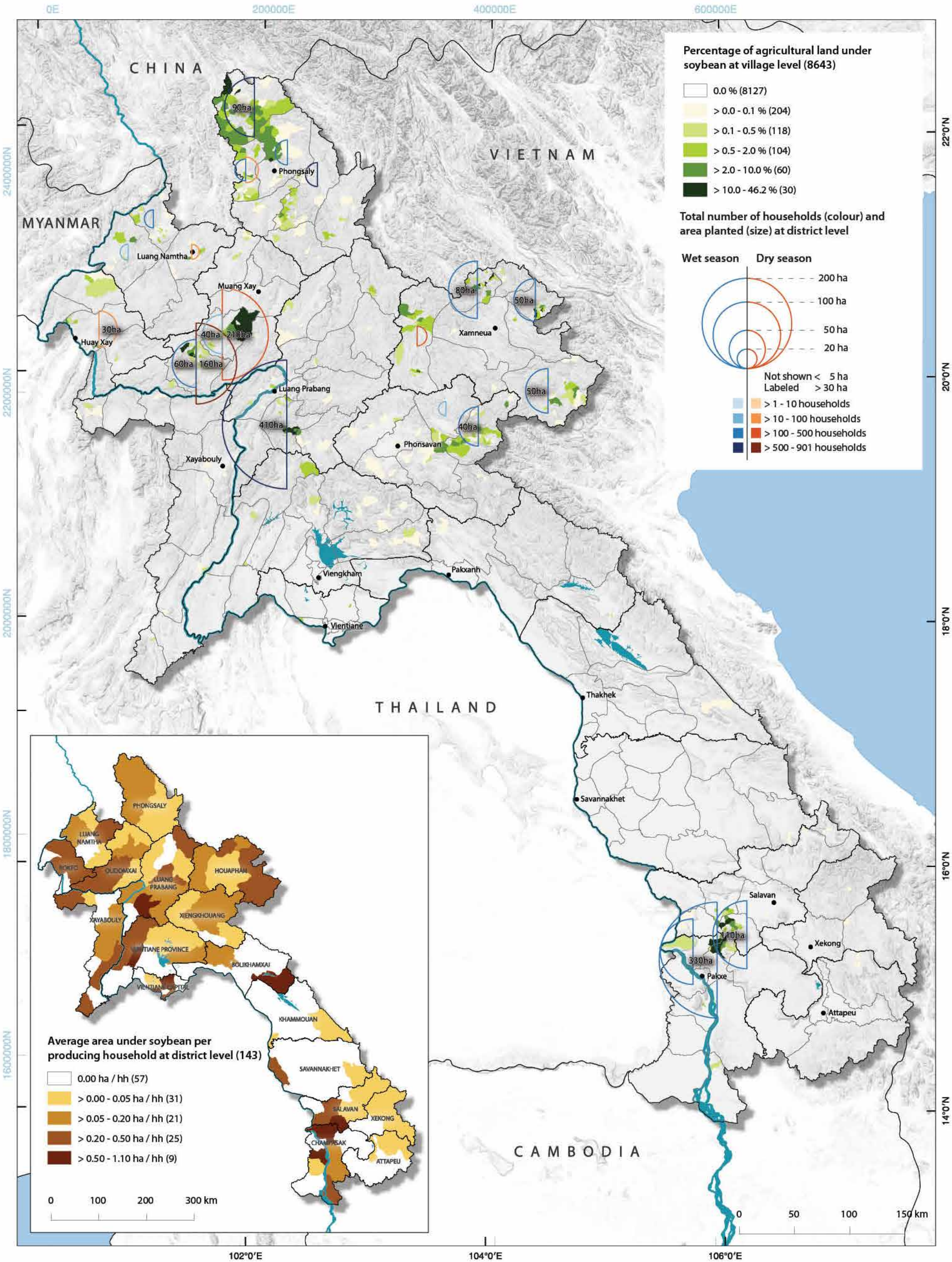
Patterns of soybean cultivation in 2011

Soybeans are produced on 1,906 ha of land in the Lao PDR in 516 villages. Most of these villages use only a small portion of their agricultural land for soybean cultivation. Only 30 villages use more than 10 percent of their land, and the maximum portion of agricultural land under soybeans in a village is 46.2 percent. Thus, soybeans are a relatively underdeveloped annual crop in the Lao PDR.

Around 1,500 ha of soybeans are grown in the wet season on rain-fed fields and approximately 450 ha are grown in the dry season under irrigation, particularly alongside river banks. The spatial distribution of cultivation is fairly scattered, though most villages which grow soybeans are in the north and the few villages that devote more than 10 percent of their total agricultural land to soybeans are located in Phongsaly and Houaphan, central Oudomxai, Xieng-ngeun District in southern Luang Prabang Province, and in the region between Pakxe and Salavan town.

The semicircles on the map show the total area planted and the number of households at district level, for which blue stands for area of soybeans cultivated during wet season and orange stands for dry season. Beng and Houn Districts in Oudomxai, located alongside the Nam Beng River, cultivate 210 ha and 160 ha during dry season respectively. In Beng District, 493 households cultivate soybeans during the dry season (at 0.42 ha/hh), whereas in Houn District, 582 households cultivate soybeans during the dry season (at 0.27 ha/hh). In the wet season, only 40 ha and 60 ha are cultivated in Beng and Houn Districts respectively.

In total, there are 6,856 households engaged in soybean cultivation, which is under 1 percent of all agricultural households in the Lao PDR. In only 9 districts is the average area of soybean production per household over 0.5 ha, whereas the national average is only 0.3 ha per producing household.



Changes in soybean cultivation patterns between 1999 and 2011

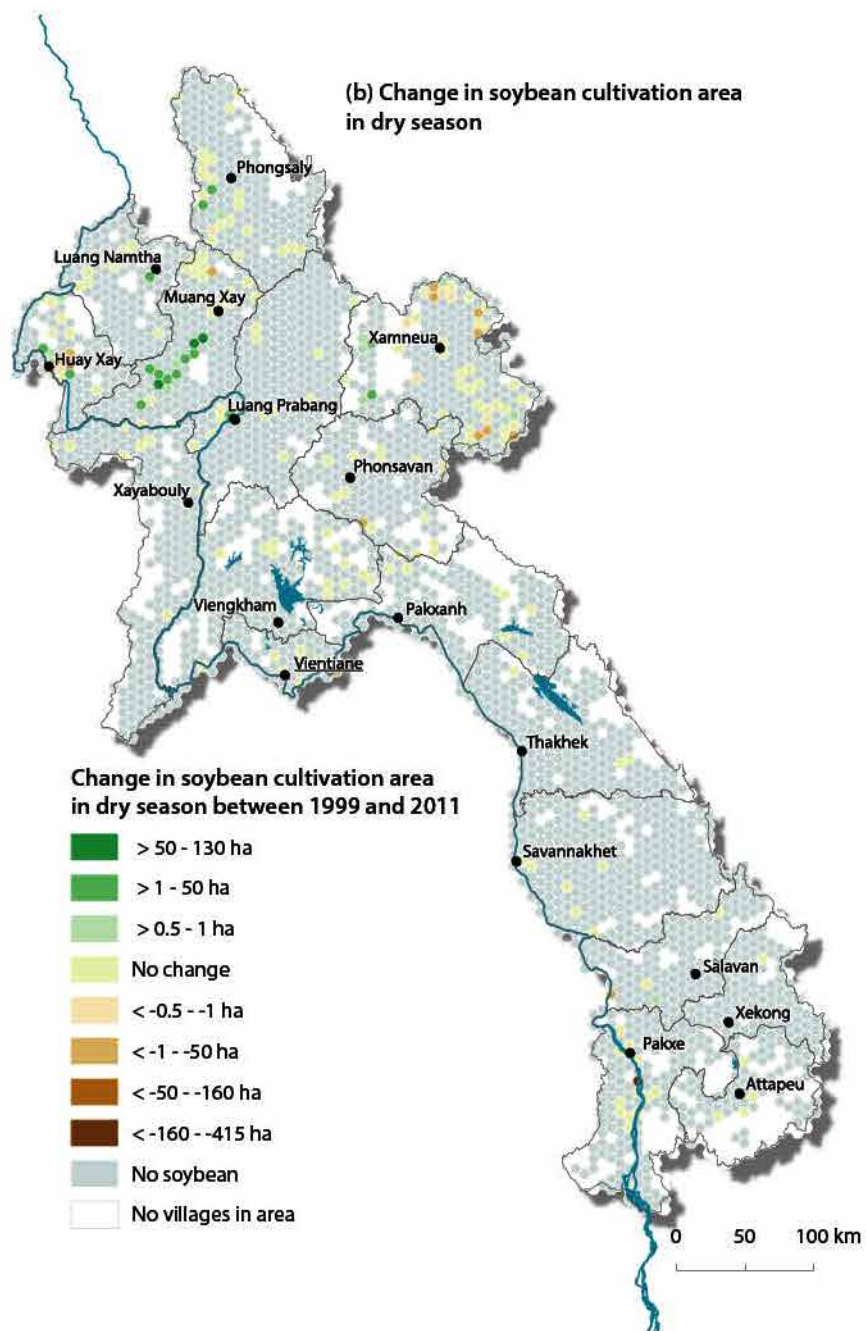
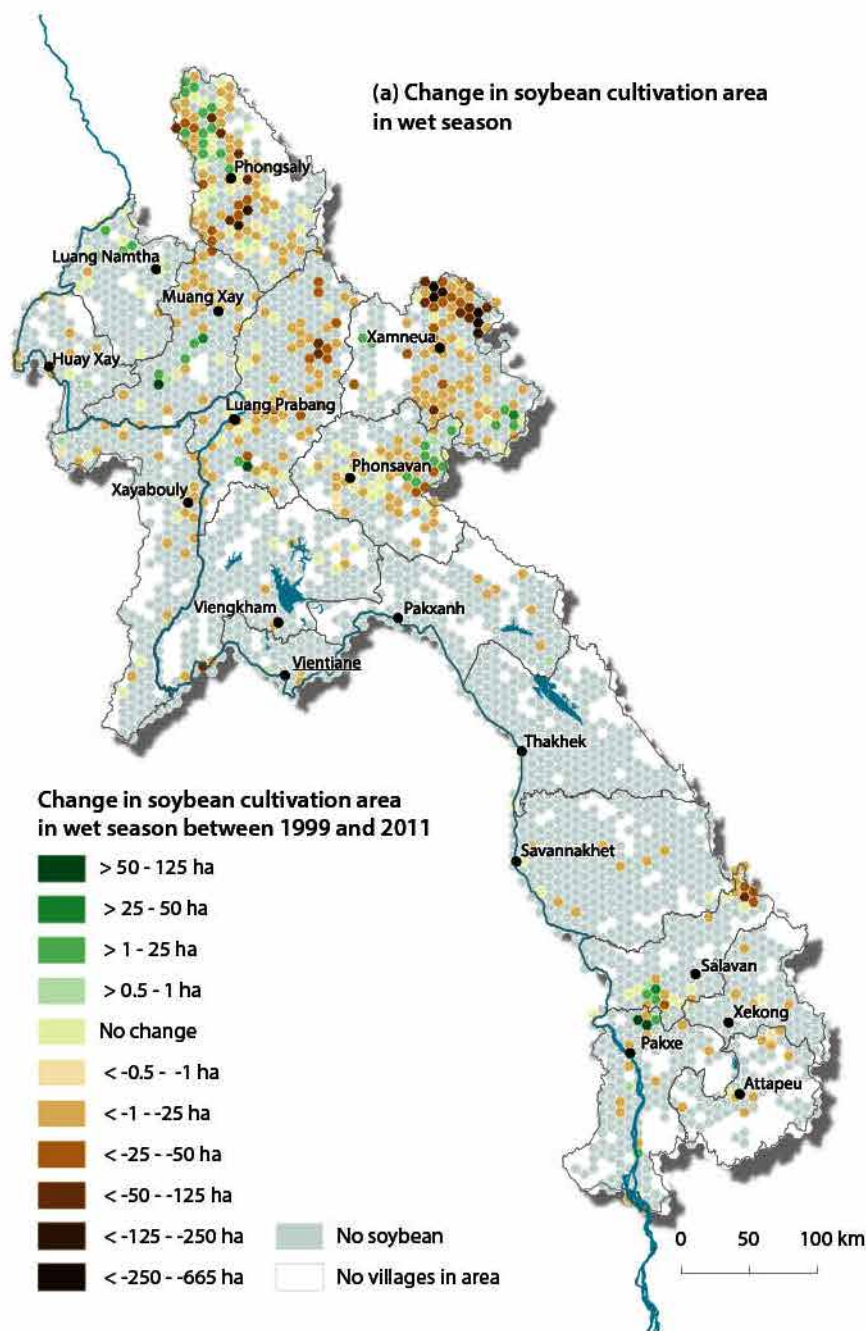
The area under soybean production decreased throughout the country between 1999 and 2011, most significantly in the northern provinces. The area declined 77 percent within a decade - from 8,289 ha in 1999 to 1,906 ha in 2011. In 1999, Houaphan had the highest soybean production area in the country, particularly in the villages bordering Vietnam in the northeast (Et and Xiengkho Districts). By 2011 the production area declined by 3,472 ha while in many regions of Houaphan production stopped entirely. In Phongsaly production declined by a total of 1,543 ha during the same period. This drop in soybean production occurred across the country with the exceptions of Oudomxai and Luang Namtha. The soybean area in Oudomxai, namely in Beng and Houn Districts, increased nearly threefold from 166 ha to 469 ha. Table 3 gives detailed information about soybean area and their changes in 1999 and 2011 at province level.

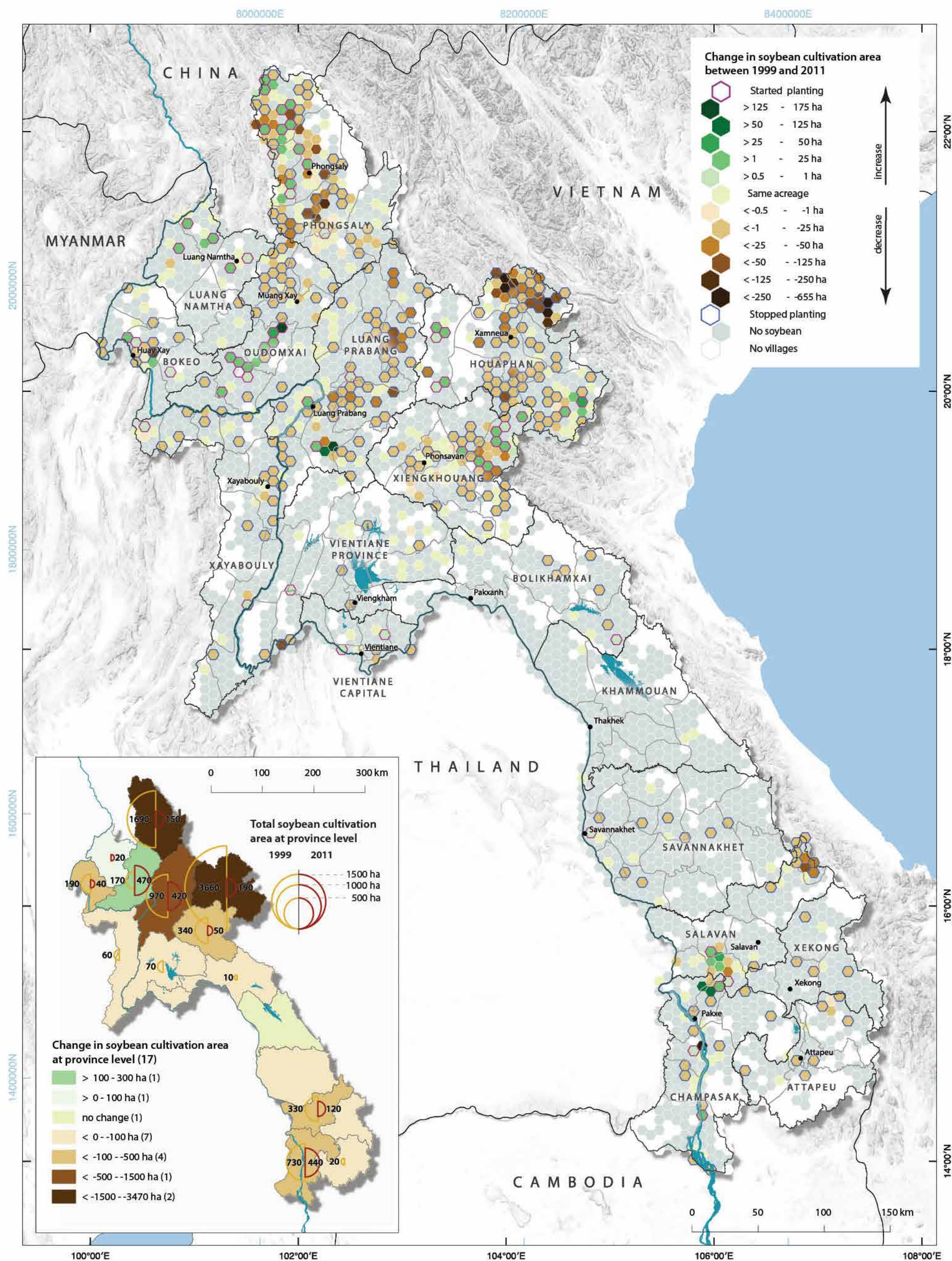
The decline in production area in the wet season was more significant (both relatively and in absolute terms) than that in the dry season. The wet season production area dropped by over 6,000 ha and the dry season area by more than 200 ha. The sharp decline was particularly found in the northern uplands along the borders with Vietnam and China.

Interpretations

GoL policies play an important role in these changes. In attempting to eradicate opium production and stabilize shifting cultivation practices in northern Lao PDR, soybean was one of the cash crops promoted as an alternative crop that could increase and diversify farmers' income sources.

Fluctuating market prices, flagging market demand, and limitations to farmers' existing skills in soybean production, however, were factors leading to the decline in the production area. There has been high market demand from Thailand for soybeans since the 2000s, but significant obstacles have prevented Lao soybeans from entering the Thai market. The scale of production in the Lao PDR was too small to enter that market, transportation costs too high, and productivity per land unit too low due to the use of local varieties and the unpredictability of climate. As a result, Lao farmers' have not been able to compete with bulk industrial suppliers from Brazil and the USA.





C16 Sugarcane

Introduction

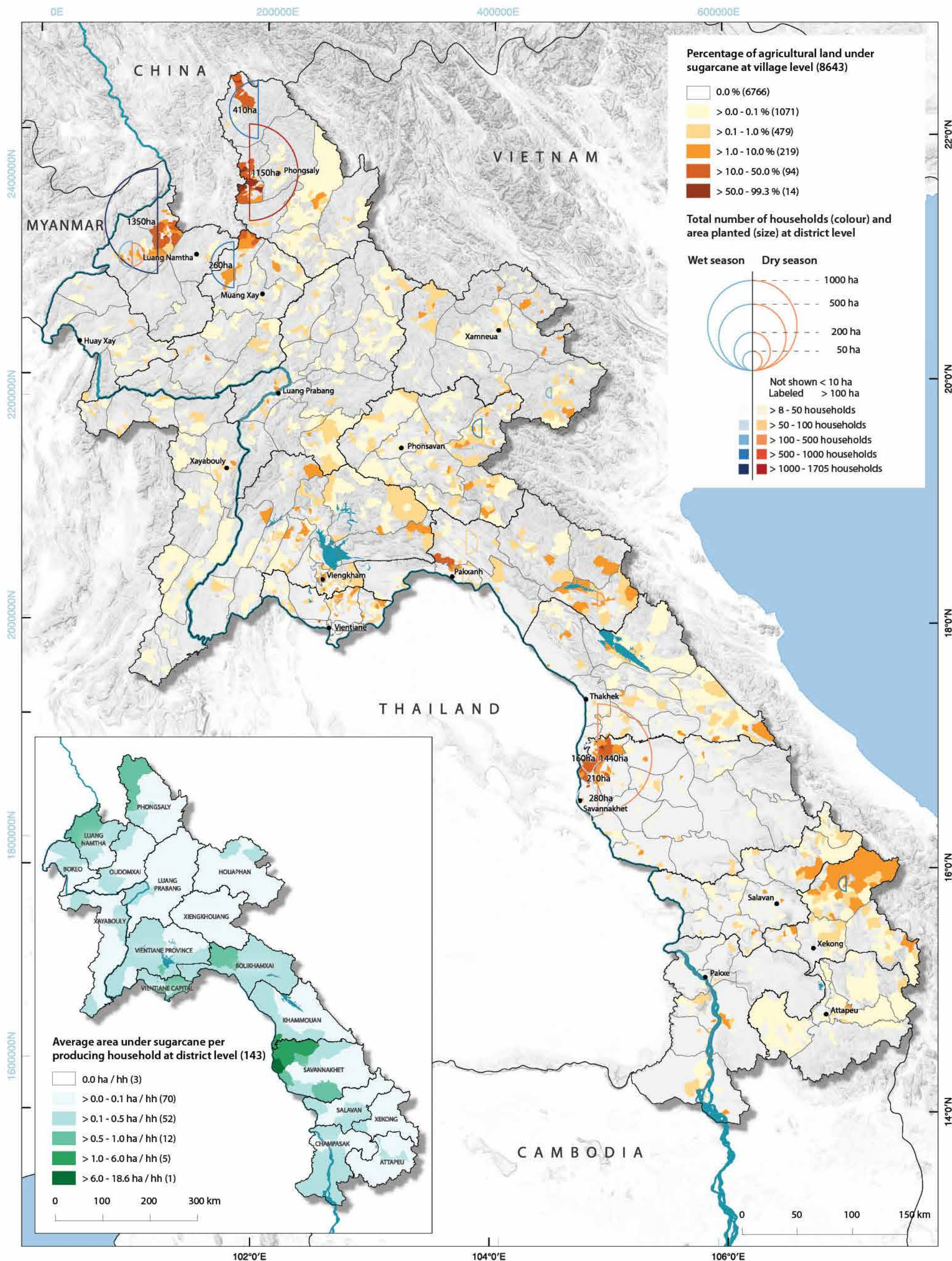
Sugarcane is the common name of several species of the genus *Saccharum* and belongs to the family *Gramineae* or *Poaceae*. The genus *Saccharum* has five important species including *S. officinarum*, *S. sinense*, *S. barberi*, *S. robustum* and *S. spontaneum*. The first three species are cultivated species and the latter two are wild. Sugarcane is indigenous to India and is a tropical crop requiring a hot climate. However, sugarcane also grows well in subtropical climatic conditions where temperatures range from 20 - 35°C. Sugarcane is a cash crop relatively newly introduced to the Lao PDR by its neighbouring countries seeking new supplies for their growing sugar factories. Currently, Savannakhet Province has the most significant industrial sugarcane sector in the Lao PDR with large-scale plantations employing advanced production approaches and technologies (IUCN and NERI, 2011).

Patterns of sugarcane cultivation in 2011

Sugarcane is grown in the lowlands as well as in the uplands of the Lao PDR during both the wet and dry season. A total of 6,449 ha sugarcane is cultivated, of which 3,155 ha is grown during the wet season and 3,294 ha during the dry season. Among the 1,877 villages that cultivate sugarcane, only 108 use more than 10 percent of their agricultural land, and a mere 14 villages use more than 50 percent of their agricultural land for sugarcane. There are two cluster regions for sugarcane planting: along the Chinese border in Luang Namtha and Phongsaly, and in Savannakhet along the border with Thailand.

Sugarcane is cultivated at significant scales in Sing District, Luang Namtha, in the areas surrounding the district capital. 1,350 ha are grown there by 1,705 households. A smaller but also notable centre of sugarcane production is Namo District in Oudomxai Province with 260 ha cultivated by 562 households in the wet season. Sugarcane is also planted in Bounneua District in Western Phongsaly, where 1,403 households plant 1,150 ha of sugarcane in the dry season, mainly along the many rivers there (e.g. Nam Boun, Nam Nou or Nam Hoy) where water is available. In Gnot-ou, the northernmost district in Phongsaly, 410 ha are grown by 740 households in the wet season. The second sugarcane cluster region is northwest Savannakhet Province, where sugarcane is planted primarily in the dry season. 1,440 ha are grown in Xaibouly District by 260 households and 280 ha in Kaysone Phomvihane District by 13 households. Sugarcane is also grown during the wet season in Savannakhet: 160 ha in Xaibouly by 59 households and 210 ha in Outhoumphon District by 56 households.

The small inset map shows that large scale sugarcane production occurs in northwest Savannakhet Province. In Kaysone Phomvihane District, the average operating area per household is 18.6 ha, and in the four neighbouring districts northeast of that district the averages range from 1.0 - 6.0 ha. In contrast, in Phongsaly and Luang Namtha the average operating area per household is less than 1.0 ha.



Changes in sugarcane cultivation patterns between 1999 and 2011

The area under sugarcane production decreased only slightly between 1999 and 2011, though the temporal and spatial patterns changed significantly.

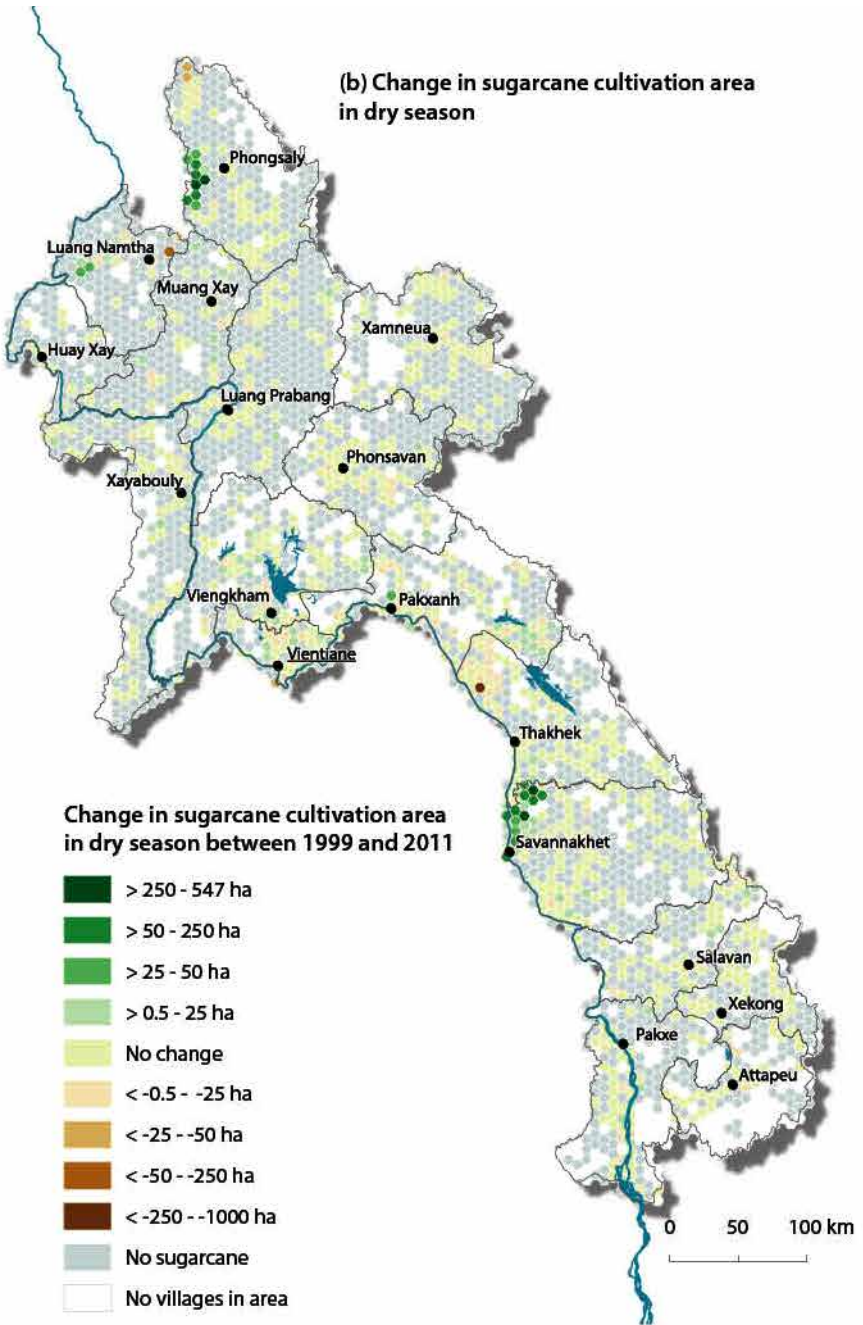
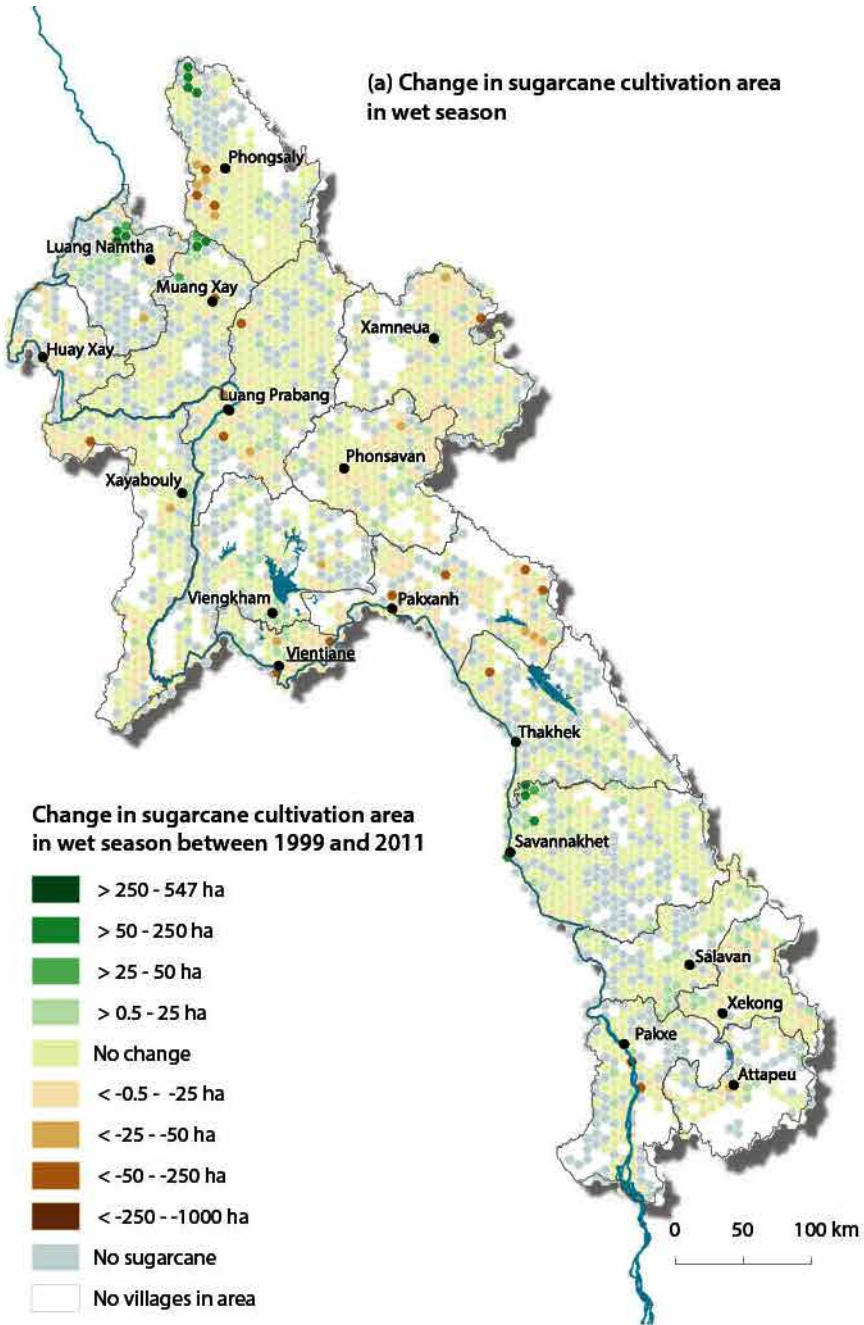
Temporal changes occurred in terms of how much sugarcane is planted in each season. In 1999, 6,057 ha of sugarcane was grown in the wet season compared to only 977 ha in the dry season, whereas in 2011 approximately the same area of sugarcane was cultivated in both seasons (3,155 ha in wet season and 3,294 in dry season). Furthermore, shifts in the spatial distribution of sugarcane production occurred between 1999 and 2011, particularly in Bolikhamxai and to a smaller degree in Khammouan and Champasak where cultivation declined. In contrast, the area under sugarcane in Luang Namtha, Phongsaly and Savannakhet increased. The number of households engaged in sugarcane production nationwide increased by 7,438 households (from 5,715 to 13,153) between 1999 and 2011, with the main areas of increase in northern Laos.

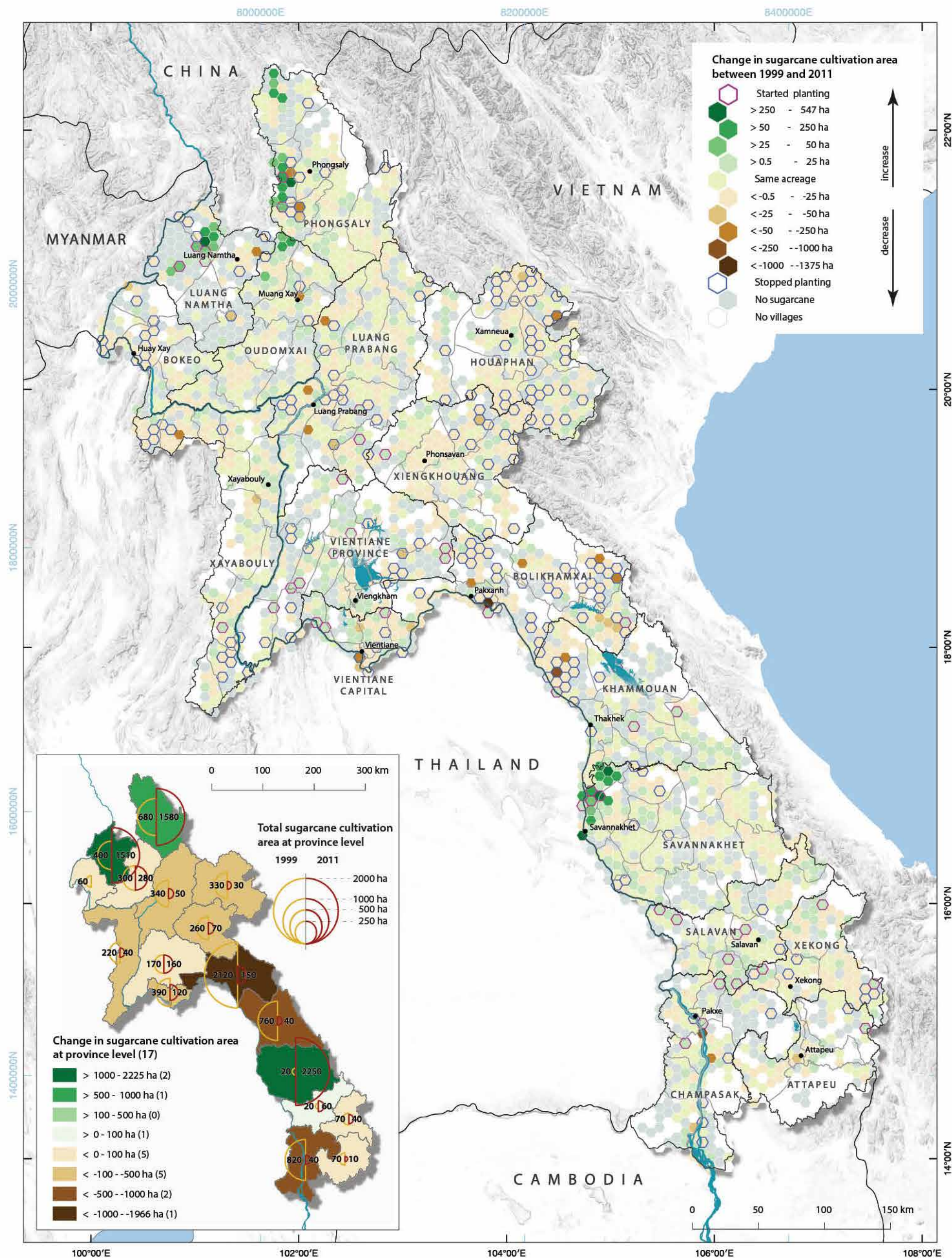
Interpretations

The decrease in sugarcane planted in Bolikhamxai between 1999 and 2011 was mainly the consequence of high demand on the Chinese market for cassava, which drove up prices for that crop. Most sugarcane production areas have been therefore replaced by maize or cassava (see C11 and C13). The decline in sugarcane production in Champasak, similarly, was the consequence of the expansion of coffee plantations (see C21), vegetables and other crops in that province.

In 2008, a sugar factory was established in Savannakhet by the Mitr Lao Sugar Company. The company engaged in 2+3 contract farming, a term used in the Lao PDR for a contract model in which farmers contribute land and labour (the 2 in 2+3), and the company provides inputs, technical advice and market access (the 3 in 2+3), for long-term periods of typically up to 40 years. In Savannakhet, sugarcane has since become a new income source for farmers (IUCN and NERI, 2011).

A similar contract farming model was implemented in Sing District, Luang Namtha Province, by a Chinese sugar factory (owned by YingMao Sugar Company). The factory provides financial and technical support to farmers through cooperation with the Sing District government. The district government has actively encouraged farmers to grow sugarcane, and in 2008 alone, Sing District exported 70,550 tons of sugarcane to China, with a market value of USD 1.6 million or about 8.7 percent of the district's total export value (Leebouapao and Voladeth, 2011). In the course of establishing sugarcane on this land, large areas of former shifting cultivation fallow have been turned into permanent agricultural land.





C17 Sweet corn

Introduction

Sweet corn (*Zea mays convar. Saccharata var. rugosa*), also called sugar corn or pole corn, is a variety of maize with a high sugar content. Sweet corn is used for three purposes: human consumption, animal feed and industrial products (Kaiser and Ernst, 2010). Sweet corn varieties differ significantly by kernel colour, which can range from yellow to white to mixed colours. There are two varieties of sweet corn, the standard and the extra-sweet variety, both of which are considered high value. Sweet corn can also be distinguished by colour, as it occurs in yellow, white and mixed colours. Sweet corn is a popular fresh market vegetable and is picked when immature (milk stage) and eaten as a vegetable rather than a grain. Sweet corn can be sold fresh, canned or frozen.

In the Lao PDR, there are two different categories of corn. One is corn for human consumption including sweet corn and sticky corn (a local variety) and the other is called seed corn or feed corn which is mainly used as a feed grain for poultry farms, pigs and cattle (see C11).

Patterns of sweet corn cultivation in 2011

In 2011, there were 33,100 ha of sweet corn cultivated in the Lao PDR, of which 29,648 ha were planted in the wet season. Sweet corn is grown in 62 percent of all villages. It is predominantly grown in more mountainous parts of the country. In total, 44 villages devote more than 50 percent of their agricultural land to sweet corn. In some districts in Oudomxai, Xayabouly and Xiengkhouang, particularly large areas of sweet corn are grown (8,070 ha, 6,482 ha, and 4,209 ha respectively). These three provinces contain 57 percent of the total area under sweet corn. Table 4 gives detailed information about sweet corn cultivation across all provinces.

In total, 108,105 households plant sweet corn on 33,100 ha. Producers therefore cultivate an average of 0.3 ha per household, though the district level inset map illustrates that there are significant regional

differences in the average area planted per household. In Phongsaly, for example, 12,693 households are engaged in sweet corn cultivation, which is the largest proportion (12 percent) of total agricultural households of any province. But the total area under sweet corn in Phongsaly is still relatively small at only 2,281 ha, because households only cultivate 0.2 ha on average (compare C13, C14 and C16). In contrast, in Xayabouly, 6,588 households farm 6,482 ha at an average of 1.0 ha per producing household. The highest average area planted per household is found in Kenthao District, located in the south of Xayabouly Province, where producing households have an average of 3.2 ha of sweet corn.

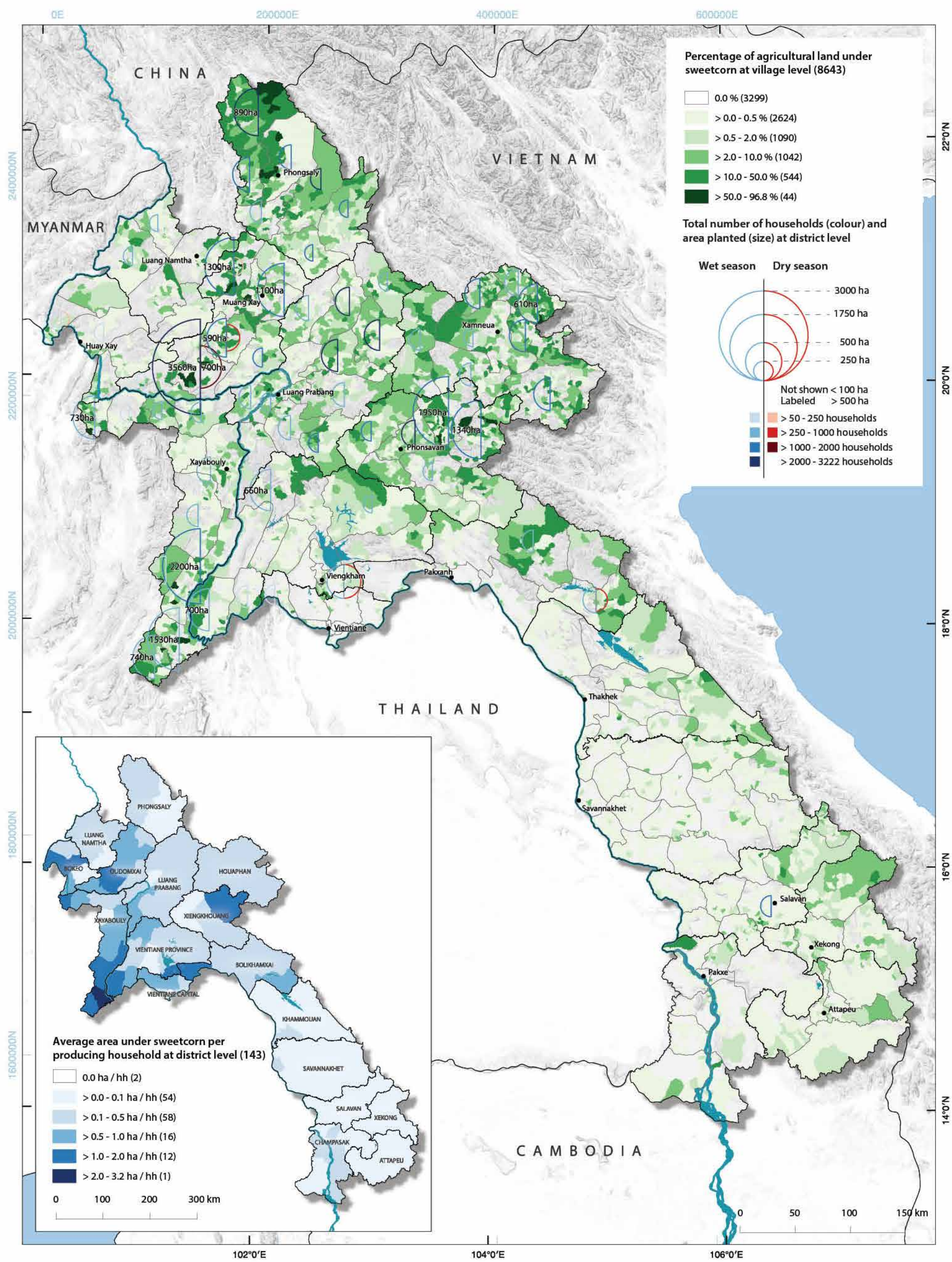
Potential and limitation for sweet corn production

Various studies point out that some lowland areas with irrigation facilities have changed from irrigated dry season rice to irrigated dry season sweet corn. Irrigated sweet corn production earns relatively good economic returns for farmers compared to irrigated dry season rice and consumes less water (Sourideth *et al.*, 2011). The labour requirements for sweet corn production are also much lower than for rice cultivation.

As a result, farmers in many areas such as Ban Keun in Vientiane Province, Ban Mouangkhai in Savannakhet Province and Ban Kokdeua in Champasak have abandoned rice production in the dry season and adopted sweet corn (Sourideth *et al.*, 2011). Sweet corn is suitable for a family with insufficient labour, but is an inappropriate option for households with a lack of investment capital. On the other hand, sweet corn production uses more fertilizer than typical rice production and can lead to soil degradation.

Table 4: Total area and percentage of sweet corn in the wet, the dry and both seasons in 2010/11

Province	Total ha sweet corn 2010 wet season	Sweet corn cultivated in 2010 wet season (% of total)	Total ha sweet corn 2011 dry season	Sweet corn cultivated 2011 dry season (% of total)	Total ha sweet corn 2010/11 both seasons	Percentage sweet corn 2010/11 both seasons
Vientiane Capital	232.1	77.3	68.1	22.7	300.1	0.9
Phongsaly	2,164.2	94.9	116.7	5.1	2,280.9	6.9
Luang Namtha	384.2	84.9	68.3	15.1	452.4	1.4
Oudomxai	6,883.5	85.3	1,186.4	14.7	8,069.9	24.4
Bokeo	418.1	59.1	289.6	40.9	707.7	2.1
Luang Prabang	2,610.4	98.3	46.1	1.7	2,656.5	8.0
Houaphan	2,586.6	97.5	65.9	2.5	2,652.5	8.0
Xayabouly	6,411.7	98.9	70.4	1.1	6,482.1	19.6
Xiengkhouang	4,110.6	97.7	98.8	2.3	4,209.4	12.7
Vientiane	2,208.3	78.5	606.5	21.5	2,814.8	8.5
Bolikhamxai	497.9	57.7	365.7	42.3	863.6	2.6
Khammouan	175.3	61.1	111.6	38.9	286.9	0.9
Savannakhet	128.8	40.1	192.1	59.9	320.9	1.0
Salavan	438.2	89.6	51.1	10.4	489.3	1.5
Xekong	121.3	92.3	10.1	7.7	131.3	0.4
Champasak	194.2	67.5	93.4	32.5	287.7	0.9
Attapeu	82.9	88.7	10.6	11.3	93.5	0.3
Total	29,648.2	89.6	3,451.4	10.4	33,099.6	100.0



C18 Main perennial crops

Introduction

Although most arable land in the Lao PDR is devoted to annual crops, there has been a notable increase in the area under perennial crop cultivation in recent years. Perennial (or permanent) crops are defined as crops with a production cycle of longer than one year such as fruit and nut trees, banana, coffee, tea, cardamom and rubber. The area under perennial crops in the Lao PDR is around 151,000 ha, covering 10 percent of total agricultural land. However, the area under perennial crops has more than doubled over the decade from 1999 to 2011.

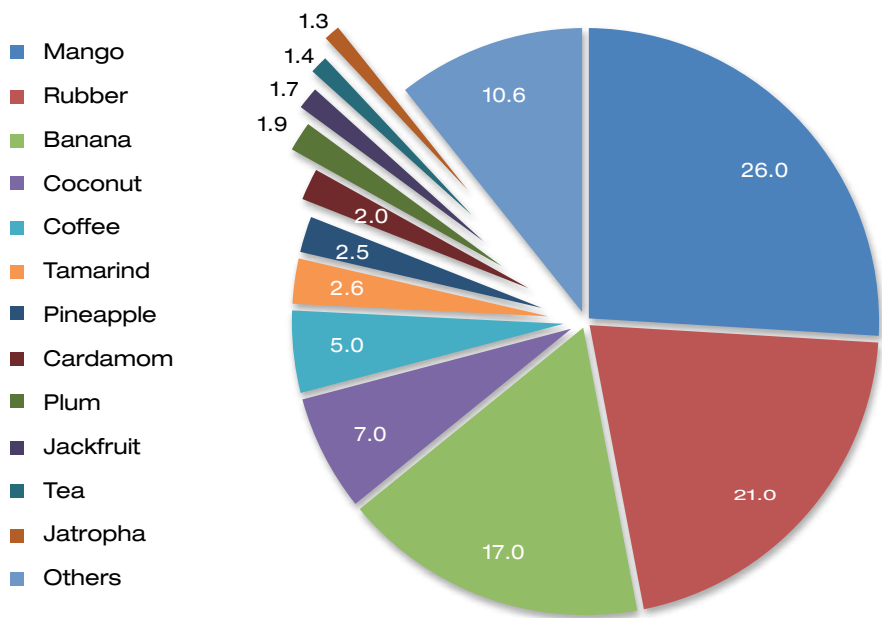
A significant increase occurred in all regions of the Lao PDR, but most prominently in the northern provinces. This was the result of various programs supported by the GoL and international donors which promoted perennial crops as alternatives to shifting cultivation. Farmers often intercrop industrial trees with pineapples and other crops during the first years of tree plantation establishment, with the main aim of securing intermediate livelihoods while waiting for trees to reach production age. Since 1999, permanent crops cultivation has increased only marginally in the south. Noticeably, larger households are much more likely to plant market-oriented perennial crops than smaller households. Farmers with small land holdings and cash constraints tend to allocate their lands to growing crops to meet household consumption needs rather than to invest in the cultivation of perennial crops.

Description of patterns in 2011

The 2010/11 Agricultural Census indicated over 80 different kinds of perennial crops grown in the Lao PDR, which broadly fall into the categories of (a) beverages and stimulants, (b) fiber crops, (c) flowers, (d) fodder crops, (e) fruits, (f) herbs, (g) industrial crops, (h) nuts, (i) oilseed crops, (j) spices, (k) trees and palms, and (l) other permanent crops. It should be noted that the types of perennial crops in the Lao PDR may be greater than what the census reports.

The map shows the dominant perennial crops planted in villages throughout the Lao PDR in terms of cultivated area. In total, 7,821 villages or 90 percent of all villages throughout the Lao PDR grow perennial crops. Mango, rubber and banana were the perennial crops planted by the largest number of villages, with 26 percent, 21 percent and 17 percent of all villages planting each crop respectively (see Figure 6). Other widely grown perennial crops include coconut (7 percent), coffee (5 percent), tamarind (2.6 percent), pineapple (2.5 percent), cardamom (2 percent), plum (1.9 percent), mandarin and orange (1.8 percent), jackfruit (1.7 percent), tea (1.4 percent), jatropha (1.3 percent) and others (10.6 percent). Oftentimes, fruit trees are planted in scattered patterns for household consumption, rather than in contiguous plantation areas, which may affect how fruit trees are represented on this map.

Figure 6: Proportion of villages by dominant perennial crop in the village



Mango is grown as a main perennial crop in almost one quarter of all villages, but less in the regions where industrial perennial crops are planted.

In the past decade, rubber plantations have been established at a huge scale in the Lao PDR. Rubber trees were most widely planted in northwestern Lao PDR, particularly in Luang Namtha, Bokeo, Oudomxai and Phongsaly, but also in central Lao PDR in Vientiane, Bolikhamxai and Khammouan. The map shows that in the northwestern provinces, but also in some central provinces, rubber has become the main perennial crop for many villages. There is also a notable amount of rubber planted in southern Lao PDR, but this is primarily done by foreign companies under a plantation model and is thus not included in this data.

Banana is a traditional perennial crop grown across the country for household consumption and sale. Bananas are grown throughout the country, but predominantly in central and southern Lao PDR. Fresh banana, fried banana chips, and grilled banana are all popular and are widely consumed in the Lao PDR. In addition, a large quantity of bananas are exported to neighbouring countries, particularly to China, Thailand and Vietnam.

Coconut trees were traditionally grown in the Lao PDR for both household consumption and sale, and trees produce for multiple human generations. Coconuts are the main perennial crop grown in 540 villages, primarily villages located in Savannakhet and in southern Champasak and located at lower altitudes with warm climates.

Coffee is cultivated by over 400 villages mostly in the four southern provinces, on and around the Bolaven Plateau. Almost 95 percent of total coffee production in the Lao PDR is produced for international markets, while only a small proportion (5 percent) is domestically consumed. Coffee is one of the five largest export commodities for the Lao PDR, which ranks third in coffee production among ASEAN countries, just after Vietnam and Indonesia, but still produces less than one percent of all coffee produced globally.

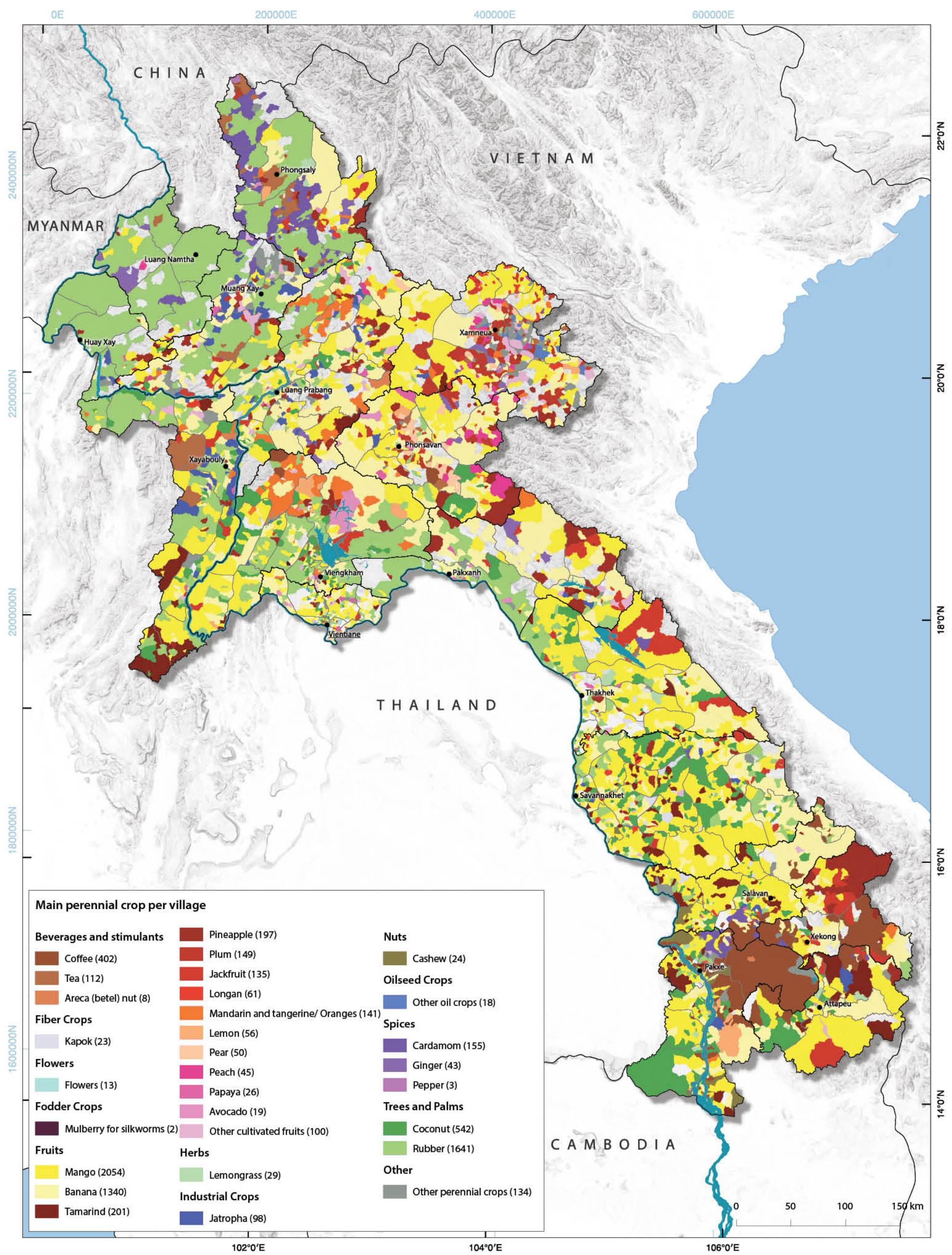
The map also depicts where cardamom is cultivated, primarily in Phongsaly and in the north of the Bolaven Plateau; tea is cultivated in Phongsaly, Oudomxai and west of Xayabouly town; mandarins, tangerines and oranges are cultivated around Vangvieng; cashews northwest of Pakxe, and tamarind is cultivated south of Xayabouly and in Attapeu, among other less widely grown perennial crops.

Interpretations

The Lao PDR has entered a phase of significant economic and agrarian transition in the last decade. Perennial crops such as rubber and coffee are not grown as food sources but as industrial inputs. Consequently, producers of these perennial crops are more dependent on global market prices. This offers on the one hand great potential to increase incomes and reduce poverty when markets are strong, but on the other hand great risk of loss for producers when market prices drop. Negative environmental impacts may also occur.

There are an increasing number of fruit processing factories in the Lao PDR that allow Lao producers to capture added value and enhanced the quality of their products. These factories allow domestic production to serve domestic markets, thus reducing imports. Moreover, these factories create jobs for local workers and contribute to reducing labour outmigration.

Laos has the potential to gain more access to export markets for the products derived from perennial crops, for example through certification schemes (e.g., organic, Forest Stewardship Council, fair trade) or Geographical Indicators (GI). Since 2009, some coffee produced on the Bolaven Plateau has been both fair trade and organic certified, and coffee chain stakeholders are working together to develop what could become the Lao PDR's very first GI. Some smallholder tea plantations on the Bolaven Plateau are also organic certified.



C19 Crop clusters - perennial crops

Introduction

A wide range of perennial crops are grown in various regions of the Lao PDR, covering 151,000 ha, equivalent to 10 percent of total agricultural land. Some perennial crops are grown in clusters in certain areas such as rubber, cardamom, tea, pear, peach, cashew and coffee. These crops are mainly grown at commercial scales for both domestic and international markets.

Description of patterns in 2011

The main map presents the share of the total perennial crop area which is devoted to selected perennial crops, indicating a high degree of regional concentration. The regions close to China and around the Bolaven Plateau have a particularly high percentage of perennial crops. The smaller inset maps show in greater detail the particular areas where certain perennial crops are cultivated in concentrated clusters.

Rubber, for example, expanded rapidly in the Lao PDR through investment by foreign companies, local elites, and individual farmers. The top right inset map shows that 68 percent of the national area under rubber is planted in north and northwestern Lao PDR, especially in Luang Namtha Province. A second cluster ranges from Vientiane to Khammouan, though this cluster only constitutes 12 percent of the area under rubber. Overall, almost 44 percent of the agricultural land used for perennial crops in the Lao PDR is under rubber.

Around 8 percent of all agricultural villages in the Lao PDR are engaged in cardamom cultivation. It is cultivated in two main geographical areas: in western Phongsaly Province close to the Chinese border, which constitutes 58 percent of the total cardamom area nationally, and in the region surrounding the Bolaven Plateau, which accounts for 22 percent. Overall, 4 percent of the agricultural land used for perennial crops is under cardamom.

The Lao tea sector is relatively underdeveloped but has great potential. Tea produced in the Lao PDR is mainly exported to China as Lao tea leaves are highly valued on the Chinese market. Some is processed into Pu-Er tea, which is a special product made in China's Yunnan province bordering the Lao PDR. Over 80 percent of all land under tea cultivation is concentrated in Phongsaly, Oudomxai and Xayabouly. Phongsaly alone accounts for 62 percent of the total agricultural land under tea, while Oudomxai and Xayabouly represent 19 percent of the total tea area in the Lao PDR.

Coffee is mostly concentrated on and around the Bolaven Plateau where over 80 percent of the total coffee production area of the country is located. Almost 95 percent of the total coffee production in the Lao PDR supplies international markets while the remaining small proportion is consumed locally. Overall, 30 percent of the agricultural land used for cultivating perennial crops is under coffee.

Cashew is predominantly produced in Champasak Province and Salavan Province. The two provinces combined are home to over 90 percent of the total cashew planting area in the Lao PDR. Villages use very low percentages of their total agricultural land for cashew production. Overall, less than 1 percent of the country's total agricultural land used for cultivating perennial crops is under cashew.

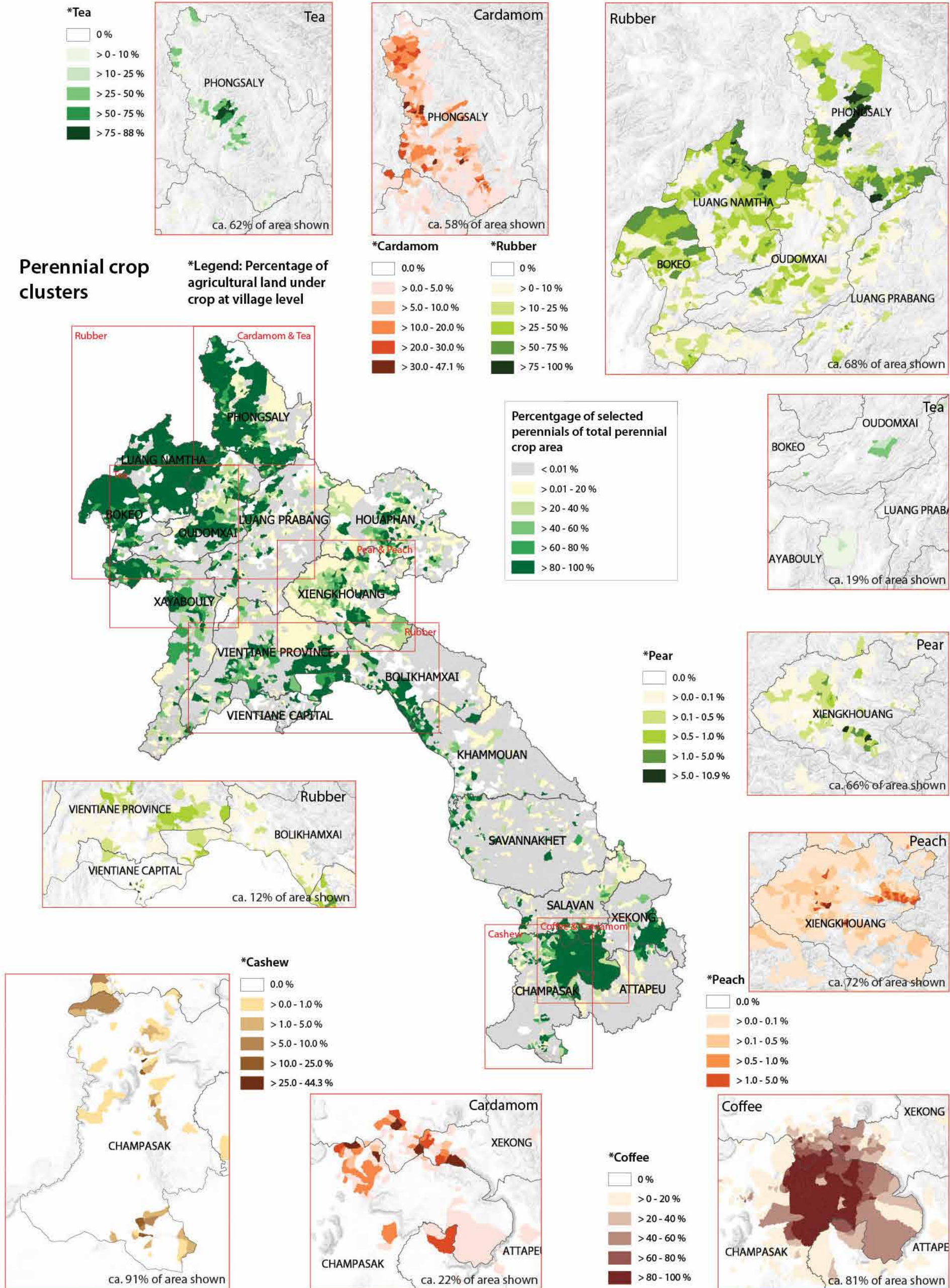
Peaches and pears are predominantly grown in cooler areas in northern Lao PDR. Xiengkhouang Province, with 66 percent of the total pear cropping area, is the predominant production location in the country. Farmers used relatively small percentages (less than 5 percent) of their agricultural land for pear cultivation. Peach cultivation is also clustered mainly in Xiengkhouang and to a smaller extent in Vientiane and Houaphan Provinces. Overall, not even 1 percent of the agricultural land used for cultivating perennial crops is under peaches and pears.

Interpretations

The high concentration of some perennial crops in certain areas in the Lao PDR predominantly occurs in areas with high market proximity, suitable soils and climate conditions, and farming communities with extensive experience growing such crops, e.g. coffee on the Bolaven Plateau. Many types of perennial crops are therefore grown in areas close to borders with neighbouring countries. Areas where certain perennial crops are grown in concentrated clusters, like in the northern provinces, may be partly a result of declining fallow periods and the increasing need to engage in multiple cropping systems in these regions.

The GoL's promotion of perennial crop plantations for domestic markets and international export focuses on areas with high potential and competitiveness in terms of agro-ecological suitability, growing experience and expertise, and market demand. It has been suggested that developing production and processing standards to meet the certification requirements for Good Agriculture Practices (GAP), Organic Agriculture (OA), and Geographical Indicator (GI) labels might not only improve the general hygiene and quality of agricultural products but also increase prices and allow Lao producers to access related specialty markets.

The uncertainty of the markets for many perennial crops may lead to food insecurity or food shortage in areas where farmers have devoted most of their land to perennial cash crop cultivation and thus rely on those crops' respective global markets for income to meet their basic needs.



C20 Rubber

Introduction

Rubber (*Havea brasiliensis*) was first introduced in the Lao PDR in 1930 when trial plots close to Pakxe town were established under a French colonial project. Sixty years later in 1990, the Phatthana Khet Phoudoi Company planted rubber first in Thakhek and in 1992 expanded into Hinboun District. Between 1994 and 1996, the Hmong village of Hadnyao in Luang Namtha Province established over 342 ha of rubber in the form of smallholdings, and these smallholders started tapping their rubber trees in 2002 (Manivong *et al.*, 2003). Rubber production in northern Lao PDR was largely driven by the influence of Chinese investors and in southern and central Lao PDR by Vietnamese and Thai investors. Since the 2000s, the area under rubber cultivation in the Lao PDR has increased at a rapid pace through planting by both individuals and private sector actors, encouraged by support from the GoL. The sudden, rapid and largely uncontrolled expansion of rubber cultivation has resulted in a total of 66,358 ha planted under smallholdings, not including rubber under concessions.

There are three models under which rubber cultivation has taken place in the Lao PDR. These include smallholdings, contract farming, and large concessions. The latter is the dominant form and covers about half of the rubber area in the country. Of the total area under rubber, 30 percent was planted by smallholders and 20 percent under contract farming (NAFRI, 2011).

Patterns of rubber cultivation in 2011

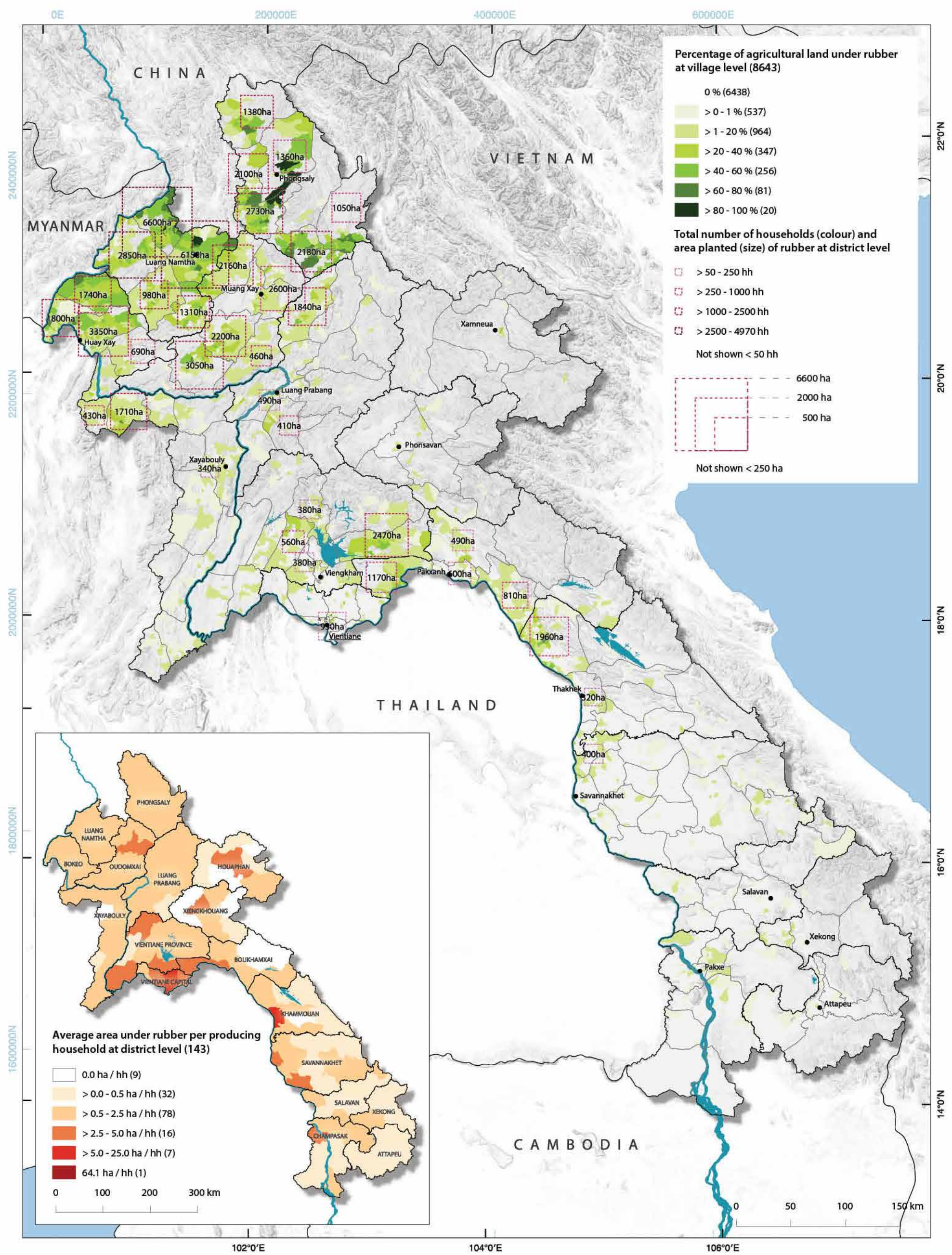
The main map illustrates the spatial patterns of household-level rubber cultivation. 26 percent of all villages in the Lao PDR grow rubber with an average area of 30 hectares per rubber growing village. 4 percent of these villages use more than 40 percent of their agricultural land for rubber (average size: 115 ha). The map demonstrates that, in large parts of Luang Namtha, Phongsaly and Bokeo, individually owned rubber takes up a significant share of the agricultural land of the respective villages.

There are almost 66,500 ha of rubber planted by 49,000 households countrywide, of which 60 percent of the cultivation area is concentrated in the above mentioned three provinces. Over 65 percent of all households in these three provinces are engaged in rubber cultivation. Other important rubber cultivation areas are the regions around the Nam Ngum reservoir and southeast Vientiane Province alongside the Mekong River running down to Khammouan.

As shown in the district-level inset map, in almost all districts there are at least some households who have planted rubber. Most of the households have, on average, less than 2.5 ha of land dedicated to rubber. In 23 districts, the average size per household is between 2.5 and 25 ha. The highest average area under rubber was recorded in Chanthabouly District of Vientiane Capital with an average of 64.1 ha per household under rubber cultivation.

Table 5: Total area, percentage and change of land under rubber in 1999 and 2011

Province	Total ha rubber 1999	% of rubber in 1999	Total ha rubber 2011	% of rubber in 2011	Change 1999 to 2011
Vientiane Capital	360.5	87.5	1,333.8	0.3	973.2
Phongsaly	7.9	1.9	10,817.3	18.0	10,809.4
Luang Namtha	29.2	7.0	17,893.3	30.5	17,864.1
Oudomxai	0.0	0.0	10,598.9	16.7	10,598.9
Bokeo	0.0	0.0	7,738.4	12.0	7,738.4
Luang Prabang	0.0	0.0	3,115.8	4.6	3,115.8
Houaphan	0.1	0.0	61.8	0.1	61.7
Xayabouly	0.0	0.0	3,191.8	6.3	3,191.8
Xiengkhouang	0.2	0.0	141.4	0.2	141.2
Vientiane	0.1	0.0	4,665.7	4.3	4,665.7
Bolikhamxai	2.0	0.4	3,108.5	2.4	3,106.5
Khammouan	2.2	0.5	2,418.5	2.2	2,416.3
Savannakhet	0.3	0.0	761.4	1.1	761.1
Salavan	2.5	0.6	85.2	0.4	82.7
Xekong	0.1	0.0	71.7	0.1	71.6
Champasak	7.0	1.7	347.3	0.4	340.3
Attapeu	0.0	0.0	7.0	0.3	7.0
Total	412.1	100.0	66,357.8	100.0	65,945.8



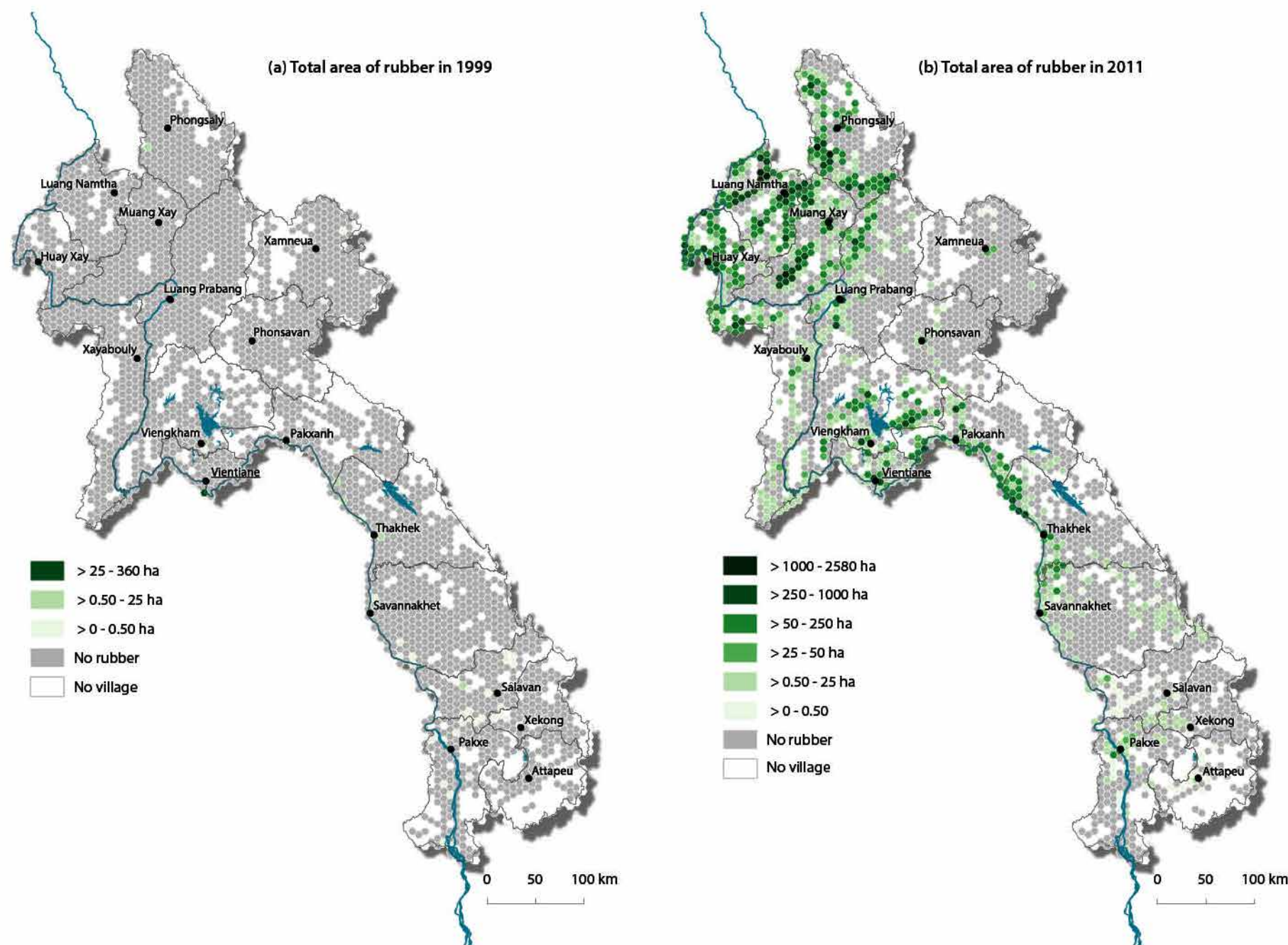
Changes in rubber cultivation patterns between 1999 and 2011

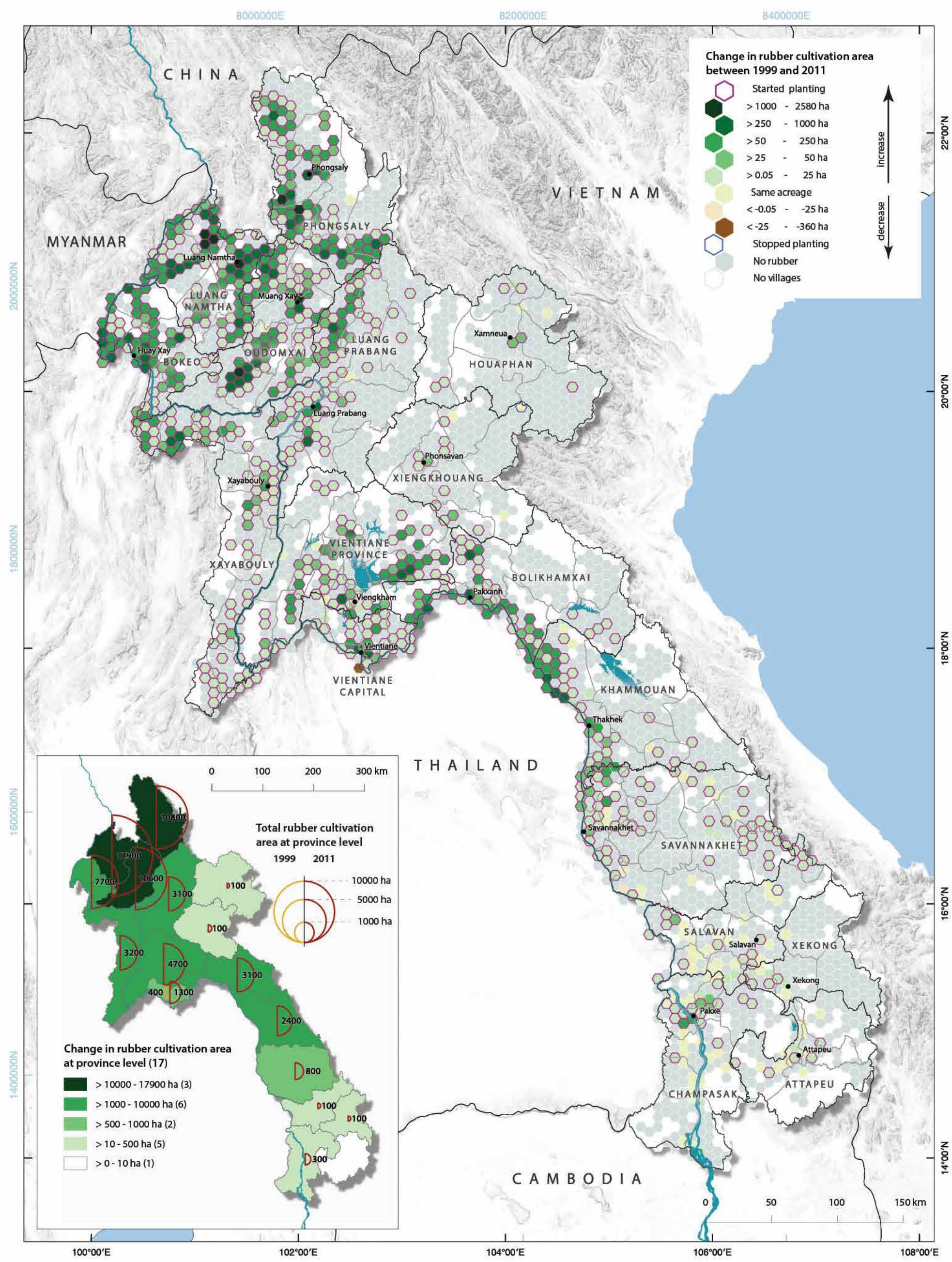
There has been an enormous increase in the area under rubber cultivation between 1999 and 2011, when the total area increased from 412 ha to 66,358 ha. The total area under rubber per province and the change in area between 1999 and 2011 are presented in Table 5.

Interpretations

Rubber has rapidly become one of the most important perennial crops in the Lao PDR over the past decade, and now plays an important role in the Lao economy. However, when rubber was first introduced, supportive policy, legislation, and institutional arrangements were not in place to effectively ensure sustainable development at the national level. Rubber planting has therefore often encroached on natural forest areas (NAFRI, 2011). While there are potential economic benefits for households involved in rubber cultivation, there are also important environmental and social impacts that merit consideration.

The fast expansion of rubber was strongly linked to national, regional and international policies supporting rubber, as well as interest among investors, in response to high market demand driven by the global tire industry, particularly in China. Rubber promotion policies in China and Vietnam which enabled and encouraged companies to invest in rubber abroad, coupled with GoL policies supporting the establishment of tree plantations, created conditions which greatly encouraged the expansion of rubber in the Lao PDR over the last decade.





C21 Coffee

Introduction

Coffee (genus: *Coffea*) was first introduced to the Lao PDR by French colonists around 1915 and was almost exclusively cultivated on the Bolaven Plateau, an area whose soils are rich in minerals, ideal not only for coffee but also for many other crops. Coffee is now the fifth largest export commodity of the Lao PDR. The volume of coffee exported increased from 14,000 tons in 2000 to 23,656 tons in 2004. Roughly 95 percent of Lao coffee production is produced for export, although the Lao PDR constitutes a minor producer (less than 1 percent) on the global coffee market.

The Bolaven Plateau covers an area of about 500 km² stretching across four provinces. It is located between the Annamite Mountain Range and the Mekong River, and ranges in elevation from 1,000 to 1,300 masl (about 500 m higher than the areas surrounding it). According to the Köppen climate classification, it is Cwa or a “Monsoon-influenced humid subtropical climate”, whereas most other areas of the Lao PDR are classified as Am and Aw – “Tropical monsoon climate” and “Tropical wet savannah climate”, respectively.

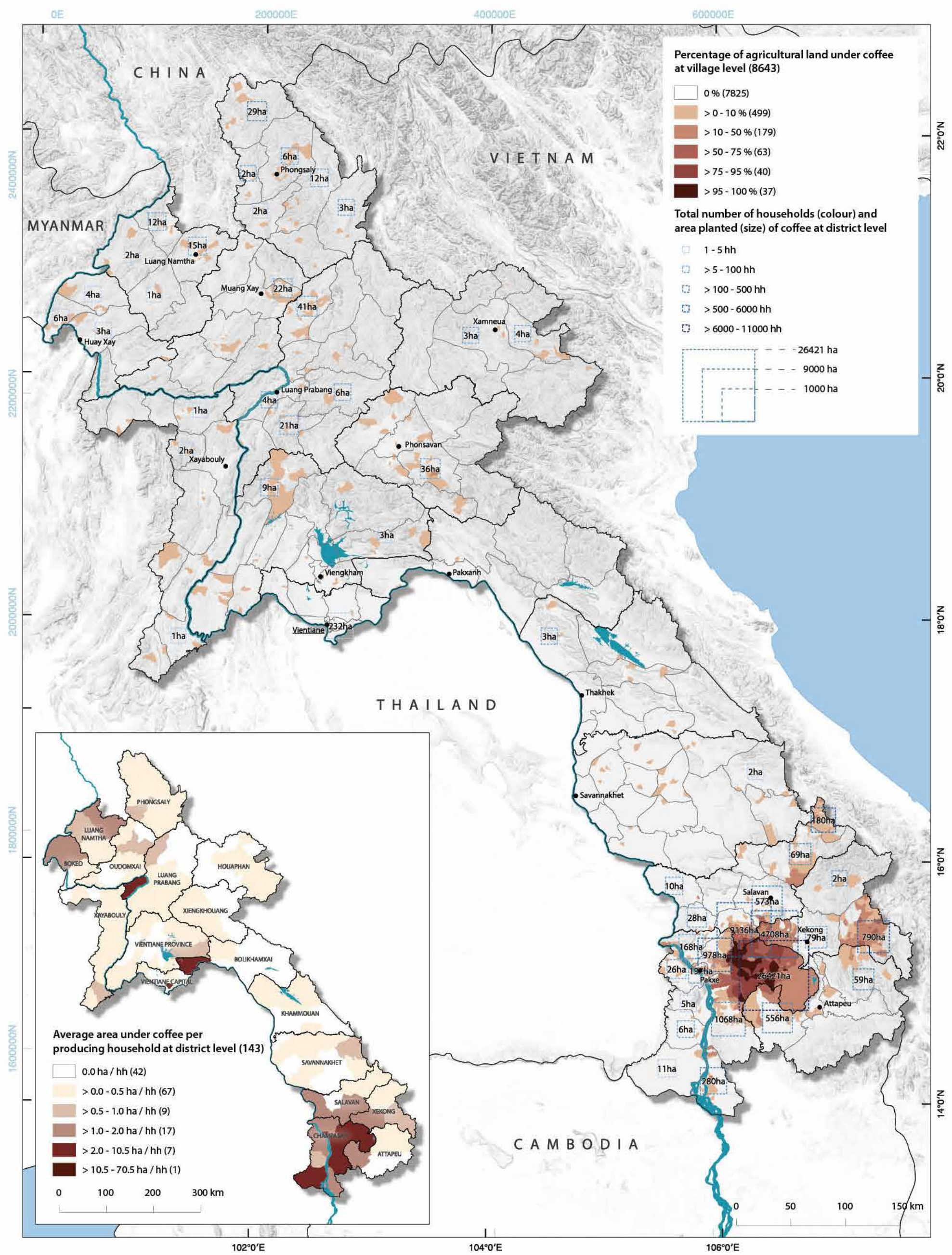
The three main coffee varieties planted in the Lao PDR are Robusta, Arabica and Liberica. Due to the spread of coffee leaf rust disease and the low price of Liberica, Robusta is the preferred variety for farmers in the Lao PDR. Robusta is resistant to disease and requires less care than other coffee varieties. However, a new dwarf hybrid Arabica Catimor is expanding in the country, and is increasingly grown in almost all coffee plantations. Arabica Catimor has several advantages, such as the low height of the trees, which makes them easier to harvest, the high possible tree planting density (2,500 trees per ha), the short harvest cycle (four years), the high yield, and the decent market price (twice the price of Robusta) (Cooper, 2014).

Patterns of coffee cultivation in 2011

In 2011, the total production area of coffee in the Lao PDR was 45,847 ha, of which, approximately 99 percent was planted in Champasak, Salavan and Xekong. Pakxong District, (located on the Bolaven Plateau) in Champasak Province, alone contributed 58 percent (26,421 ha) of the total coffee production and has 11,000 households engaged in coffee cultivation. In total, 25,220 households are involved in coffee cultivation, with 96 percent of them in southern Lao PDR. The districts surrounding Pakxong also have a high amount of land under coffee, e.g. Laongam District in Salavan Province has 9,136 ha. In Xekong Province, two conspicuous regions have coffee: Thateng District (with 4,708 ha of coffee) bordering Champasak’s Pakxong District and Dakchung District in the east bordering Vietnam (790 ha).

The main map shows the share of the agricultural land used for coffee cultivation. 37 villages on the Bolaven Plateau devote more than 95 percent of their agricultural land to coffee. 103 villages in this region use more than 50 percent of their agricultural land for coffee, which speaks to the importance of the crop for this region. Only 497 ha (1 percent) of the total coffee area in the Lao PDR occurs in central and northern Lao PDR. In these two regions, intercropping and planting coffee beneath forest canopies is common. The only notable district with more than 30 ha of coffee cultivation is Khoun District in Xiengkhouang Province.

The inset map shows the average area under coffee per household at district level. In Champasak Province, four districts have an average area between 2.0 and 10.5 ha per household. Chomphet District in Luang Prabang Province (4.0 ha/hh), Thaphabat District in Bolikhamxai Province (2.4 ha/hh), and Chanthabouly (10.5 ha/hh) and Xaisettha (70.5 ha/hh) Districts in Vientiane Capital also have high average areas of coffee per household.



Changes in coffee cultivation patterns between 1999 and 2011

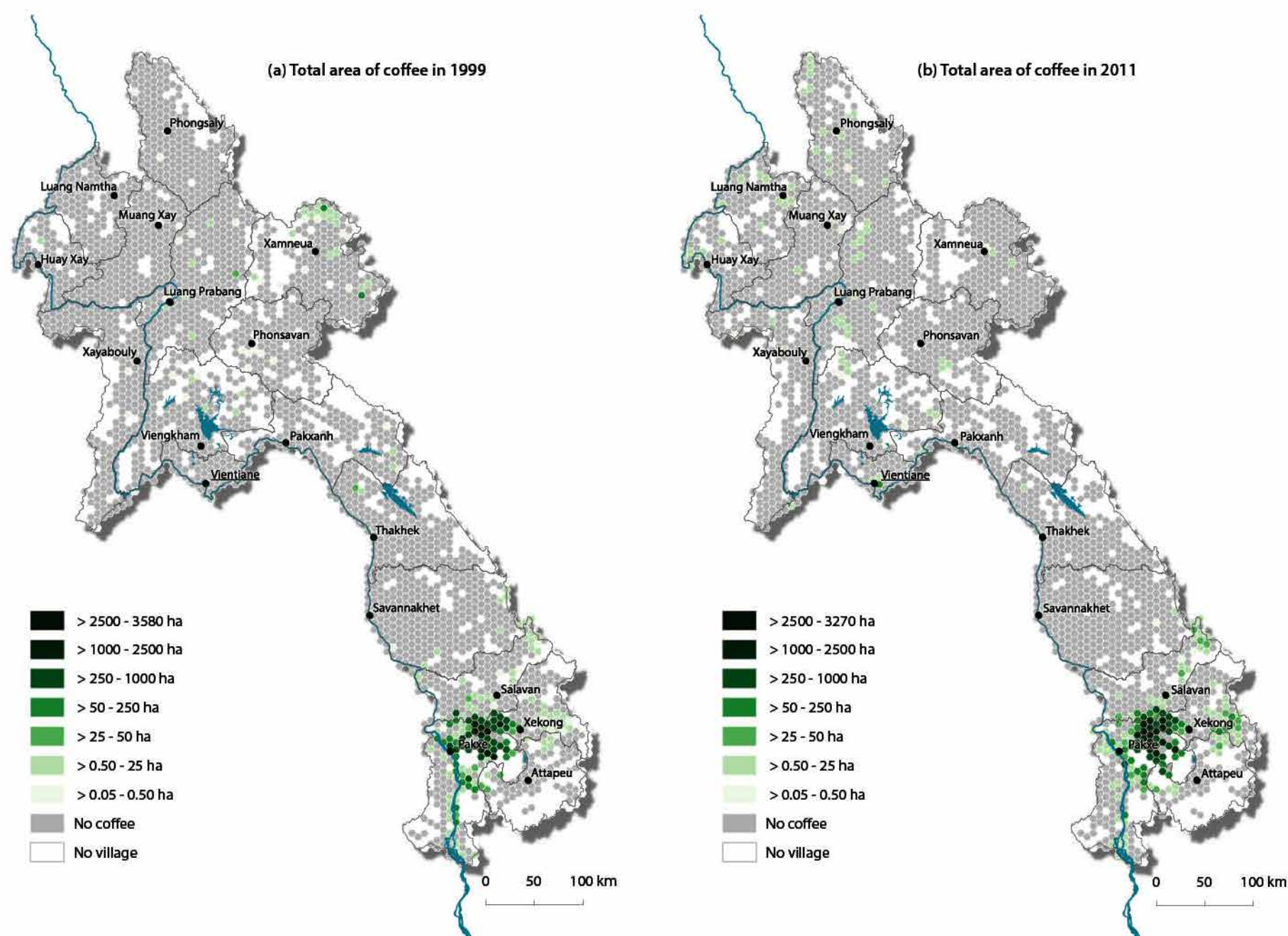
The total area under coffee cultivation remained fairly stable from 46,226 ha in 1999 to 45,847 ha in 2011. However, some regional spatial changes took place. In the south, Champasak lost 4,000 ha, whereas the cultivation area in the surrounding three provinces increased. Both Salavan and Xekong Provinces experienced increases in the area under coffee of around 1,500 ha compared to 1999 levels. In Attapeu only 89 ha of coffee was planted in 1999, but the area expanded to over 600 ha by 2011.

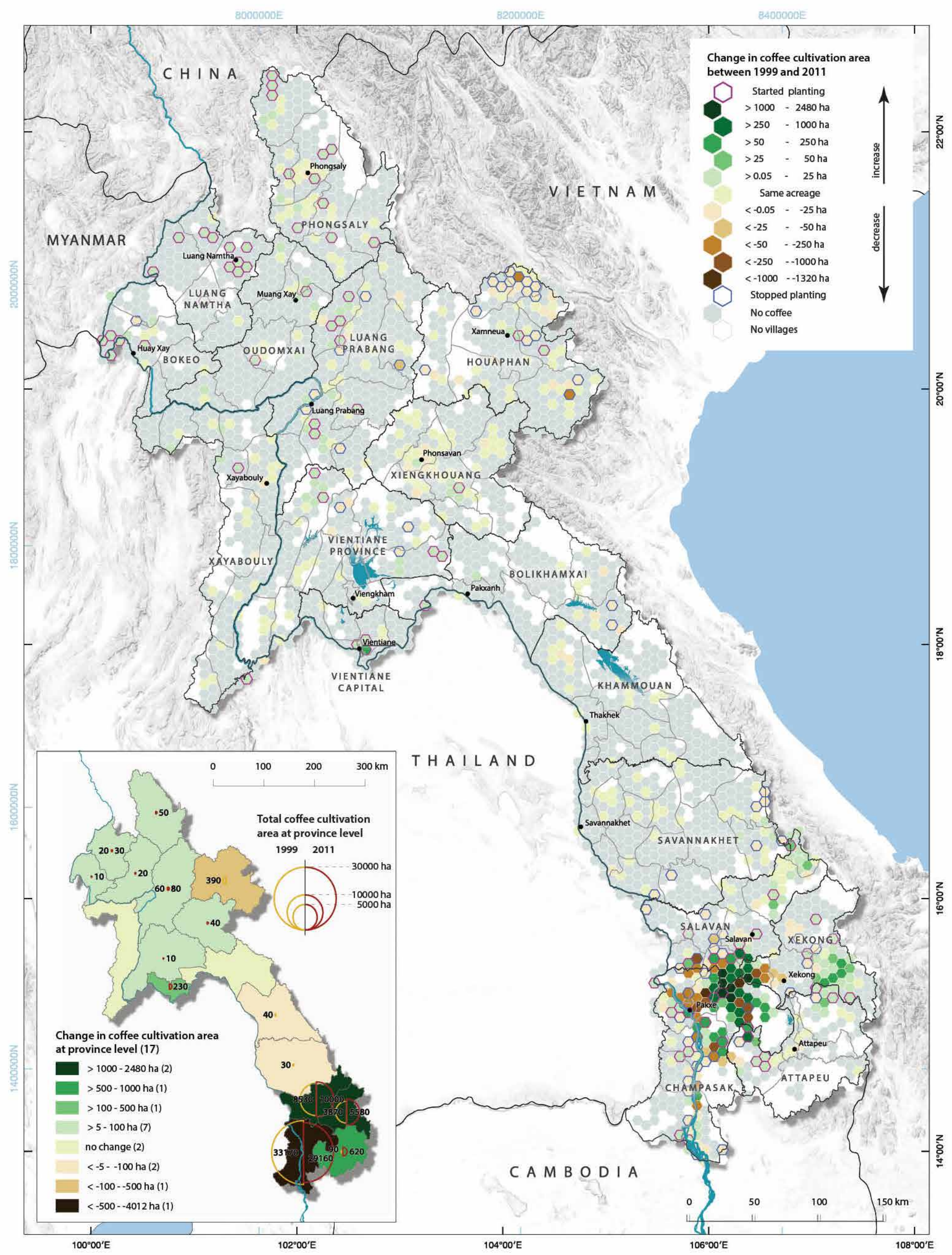
Less significant changes occurred in Houaphan Province and in Vientiane Capital. For example, in northern Houaphan Province in Et and Xiengkho Districts, some coffee planting stopped. In 1999, Houaphan Province still had almost 400 ha of coffee which nearly completely disappeared in 2011. The trend in Vientiane Capital was the other way around, from having only a few ha planted in 1999 to more than 230 ha in 2011. In the other eleven provinces, the area under coffee did not change remarkably, but in several areas some cultivation activities have newly begun.

Interpretations

Climate stresses and weaker market demand have affected the coffee sector in the Lao PDR. The country experienced a four-year cycle of low temperatures and frost (*mork keua*) in 2000, 2004, and 2008 (UN-Habitat, 2004). Coffee can tolerate low temperatures, but not frost, and coffee growers in the Lao PDR have suffered during those years when frost occurred. It created severe damage to coffee trees. In Pakxong District, for example, thousands of ha were damaged by incidents of frost.

In 2009 to 2011, global coffee prices rose due to poor harvests in South America, and this became a driver of expansion in the Lao coffee sector (Cooper, 2014). Dao Heuang, Sinouk, Mountain Coffee, and Jhai Foundation are key coffee producers in the Lao PDR. The establishment of the Lao Coffee Association, a Lao National Coffee Board, and a Coffee Producers Organization on the Bolaven Plateau have all resulted in better provision of market information, technical training, and financial access to coffee stakeholders, and all have contributed positively to the Lao coffee sector. As a result, farmers have become more organized and manage their production systems better than before. The growing interest of the EU and Japan in organic coffee has become another driver of the expansion of coffee production in the Lao PDR.





C22 Banana

Introduction

Banana (genus: *Musa*) is a traditional perennial crop grown across the Lao PDR for household consumption as well as for sale. Many local varieties of banana are planted such as *Kouay Namva*, *Kouay Ngao*, *Kouay Hom* (good smell), *Kouay Thany*, *Kouay Nok* (bird), *Kouay Khai* (egg), *Kouay Lep Mue nang* (lady finger), *Kouay Mousy*, *Kouay Typ*, *Kouay Typ Chanh*, *Kouay Kenh*, *Kouay Chia* (bat), *Kouay Som Piang* or *Kouay Khang*. Recently, an improved variety called the “Cavendish banana” has been planted in northern Lao PDR, mainly for export to the Chinese market. Commercial banana plantations have expanded significantly in recent years, but the data presented here only includes household level production, thus these commercial plantations are not reflected.

Patterns of banana cultivation in 2011

In the Lao PDR, nearly 70,000 households in 61 percent of all agricultural villages grow bananas on a total area of 9,500 ha. Salavan and Savannakhet Provinces account for nearly half of the total area under banana cultivation. As the main map illustrates, these areas are primarily located in Laongam District (1,420 ha) and in the mountainous regions of eastern Lao PDR near Vietnam, from Xepon District in Savannakhet (1,370 ha) to Ta-oy District in Salavan (240 ha) . There are 37 villages, primarily located in these districts that use more than 25 percent of their agricultural land for banana cultivation.

The district-level inset map highlights how banana cultivation is distributed across the entire country. Most of the 143 districts have an average of under 0.5 ha per producing household, which indicates that banana is planted typically on a very small scale.



Changes in banana cultivation patterns between 1999 and 2011

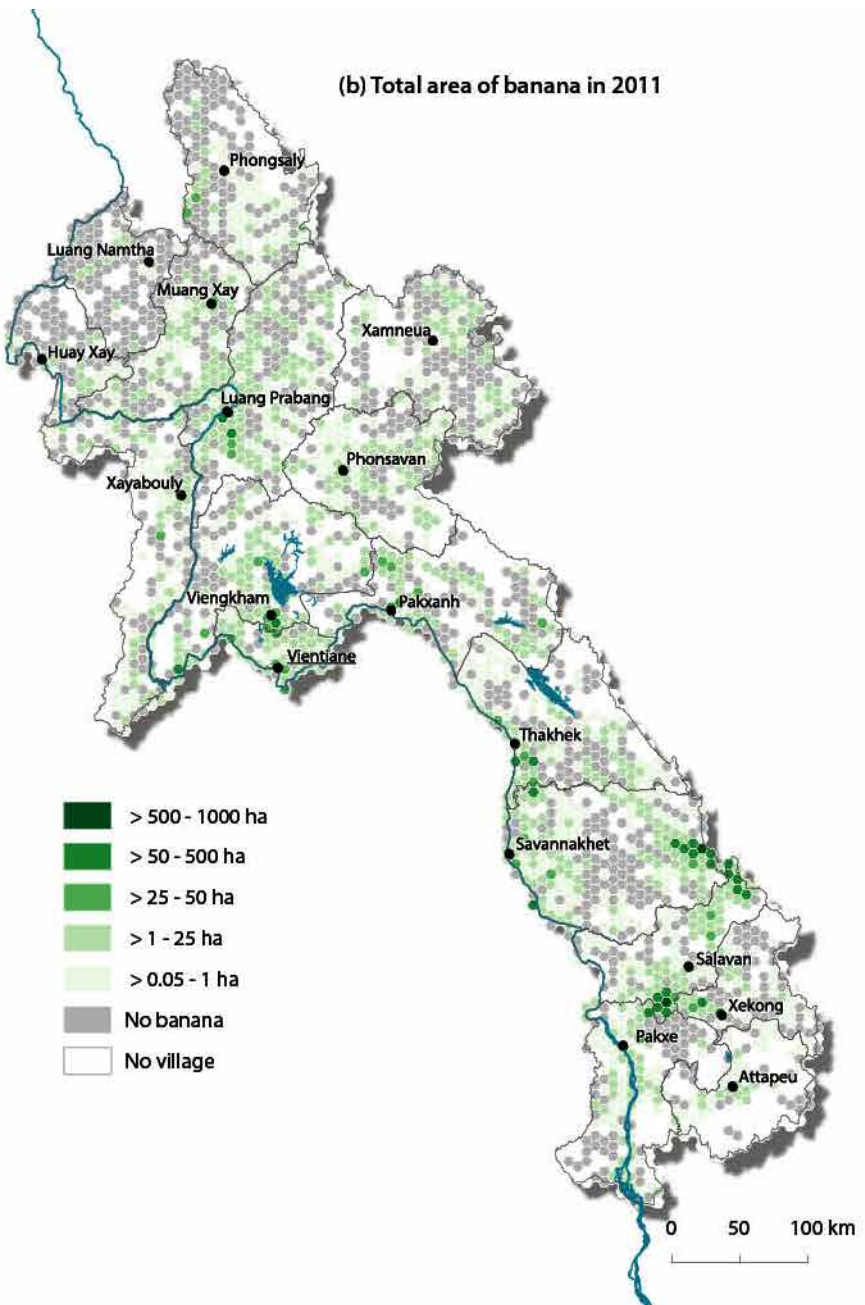
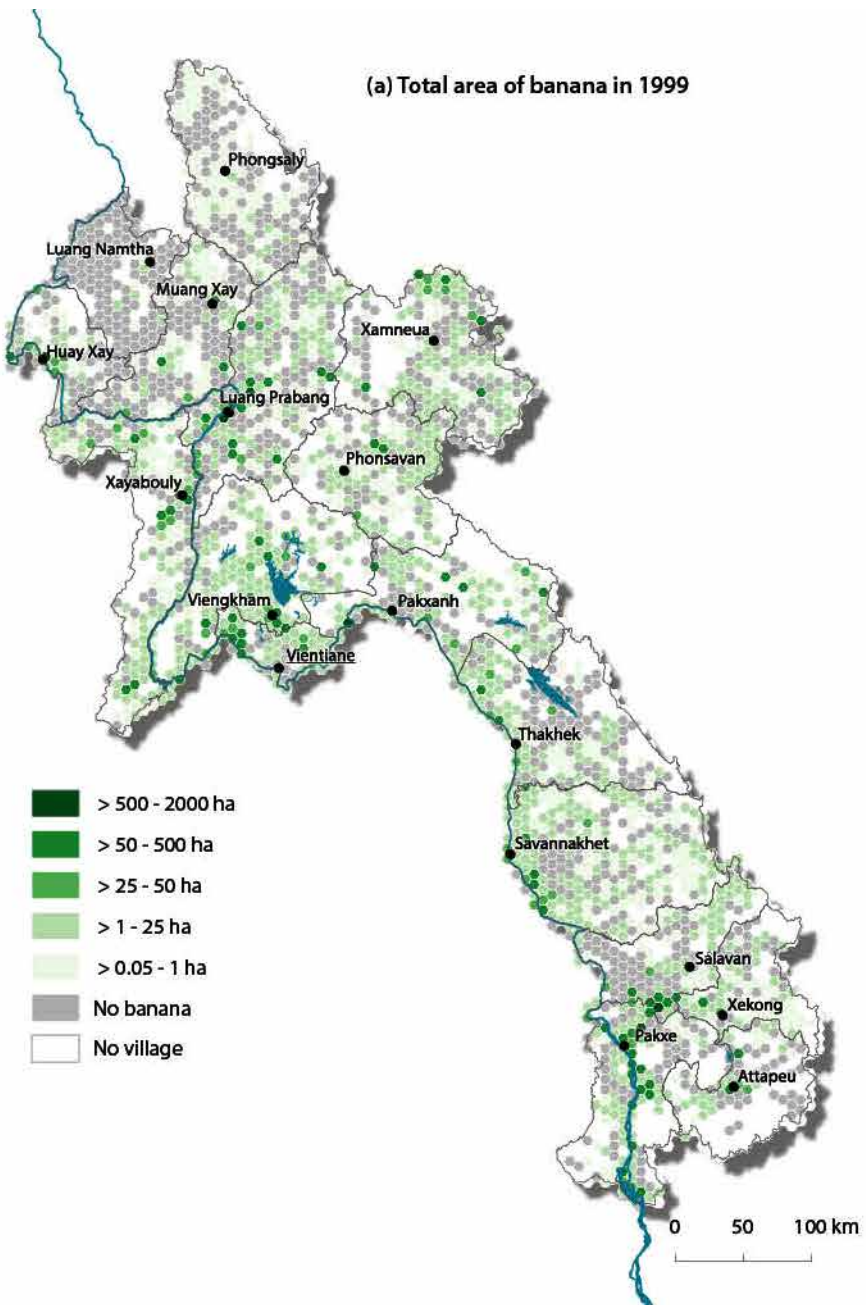
A significant decrease in banana cultivation occurred between 1999 and 2011 – from 28,800 ha in 1999 to 9,500 ha in 2011, which constitutes a decrease of 300 percent. The number of households engaged in banana cultivation also dropped from 130,000 in 1999 to 70,000 in 2011. As with cultivation area, almost all provinces experienced a decline in the number of households engaged in banana farming. In contrast, three provinces, Phongsaly, Savannakhet and Salavan, experienced an increase. In Savannakhet, banana planting occurs in relatively large areas along the Vietnam border and are sold on the Vietnamese market. Salavan has a long history of banana cultivation for the domestic market, as well as for the Vietnamese and Thai markets. Table 6 gives detailed information about the cultivated banana area.

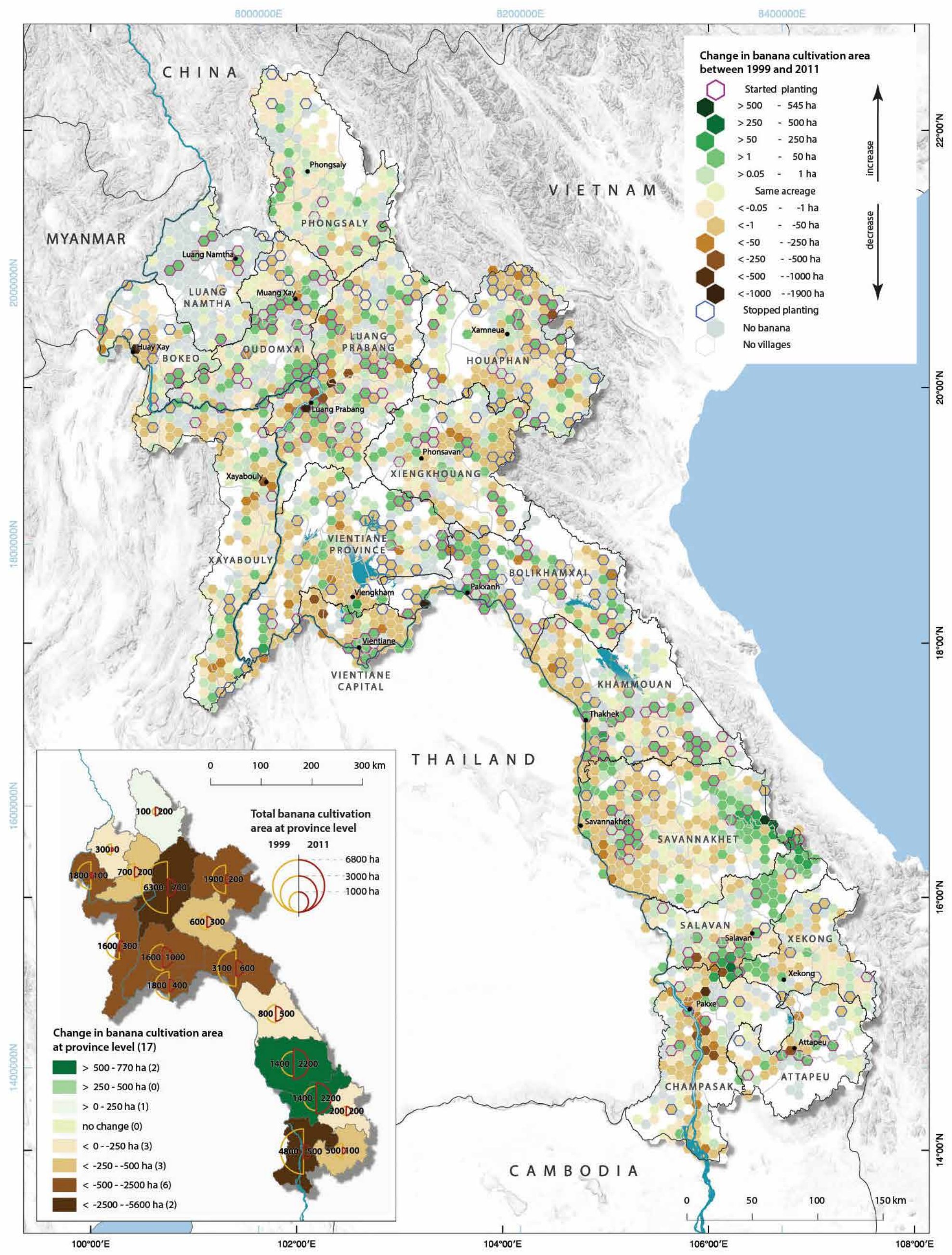
Interpretations

The notable decrease in banana cultivation across the country over the past decade occurred mainly because of a shift to other crops such as maize (see C11), Job's tears (see C12), cassava (see C13) and rubber (see C20). In contrast to the demonstrated decrease in cultivation area and in the total number of households growing banana in the last ten years, commercial banana plantations have developed rapidly, especially in northern Lao PDR, through an influx of Chinese investment. Chinese investors are attracted by cheap land, fertile soils, as well as year-round climatic suitability without a winter season interrupting production as affects the banana sector in China. The most common variety of banana planted in commercial plantations is the “Cavendish banana”, the world’s leading variety. Although the development of commercial banana plantations in the north generates wages and creates employment for some farmers, there are also various concerns about the impacts of plantations’ intensive use of chemicals on plantation workers’ health and the surrounding environment.

Table 6: Total and change of banana area between 1999 and 2011

Province	Total ha Banana 1999	Total ha Banana 2011	Change 1999 to 2011
Vientiane Capital	1,799.5	354.2	-1,445.3
Phongsaly	85.2	173.1	88.0
Luang Namtha	277.0	38.6	-238.4
Oudomxai	679.6	239.6	-440.1
Bokeo	1,764.6	89.6	-1,674.9
Luang Prabang	6,288.3	715.0	-5,573.3
Houaphan	1,879.7	180.3	-1,699.4
Xayabouly	1,647.5	262.5	-1,385.0
Xiengkhouang	617.5	274.2	-343.2
Vientiane	1,600.1	959.2	-640.8
Bolikhamxai	3,073.8	579.9	-2,493.8
Khammouan	760.4	518.6	-241.8
Savannakhet	1,422.8	2,156.4	733.6
Salavan	1,388.4	2,156.3	767.9
Xekong	199.9	197.2	-2.8
Champasak	4,784.6	491.6	-4,293.0
Attapeu	511.5	93.6	-417.8
Total	28,780.2	9,480.0	-19,300.2





C23 Cardamom

Introduction

Cardamom (*Amomum spp.*) is an herbaceous, perennial plant in the *Zingiberaceae* family, which is commonly known as ginger. In the Lao PDR, cardamom grows naturally at elevations of 700 - 1,200 masl, particularly on the banks of flowing water in forests where the humidity is high and in areas with some shade. Cardamom has been found growing wild in secondary forests over the last 50 years, particularly in northern Lao PDR, and when collected wild is considered as non-timber forest product (NTFP). But more recently, Lao farmers in some areas have begun engaging in cardamom cultivation through commercial mono-cropping systems. There are many cardamom species occur in the Lao PDR, but only two are valuable for export markets: Pakxong cardamom and Guangdong cardamom.

Cardamom production became popular in the Lao PDR between 1975 and 1980 in Banchiangchaleunsouk and Pakxong Districts of Champasak Province, and Laongam District of Salavan Province. Cardamom seeds contain essential oils, camphor, acetate, limonene and other esters. They are used as ingredients for a number of pharmaceutical supplements, in some countries in meat seasoning, to flavour coffee in the Middle East, and in baking in Europe and the USA. Cardamom is largely exported in raw form or semi-processed to China and Thailand, Vietnam, Myanmar, and the Republic of Korea for traditional medicines. According to the Ministry of Commerce and Industry, around 200 to 250 tons were exported from the Lao PDR in 1999, although because exports are often inaccurately recorded, real exports of cardamom may have exceeded these numbers.

Patterns of cardamom cultivation in 2011

Overall, 6,427 ha of cardamom are cultivated in the Lao PDR, of which 1,497 ha are in Thateng District, the westernmost district of Xekong Province. There are two main producing areas: one in northeast and southeast of Pakxe (around the Bolaven Plateau), which constitutes approximately half of the total national production area, and a second in the north along the border with China, primarily in western Phongsaly, northern Oudomxai and Luang Namtha. East of Pakxe, there are 19 villages which use more than 20 percent (up to 47 percent) of their agricultural land for cardamom cultivation, and in the above described northern region, 29 such villages. Only a few cardamom growing areas are planted in the remaining part of the country.

Around two-thirds of the 13,252 households engaged in cardamom production are located in the area in the north highlighted in the small inset map. Here, the average producing area is 0.1 - 0.5 ha per household compared to the south where producing households have on average 1.0 - 2.0 ha of cardamom.



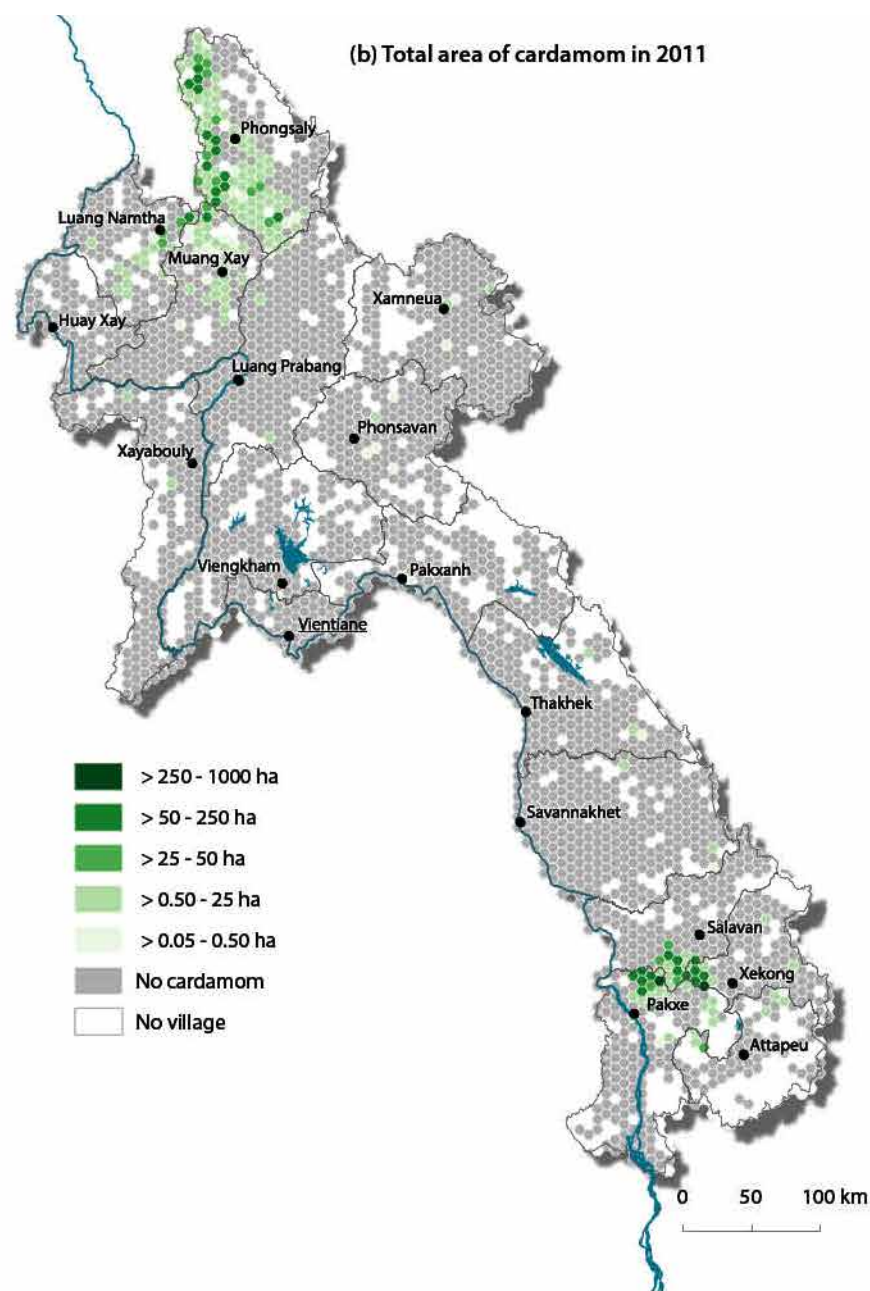
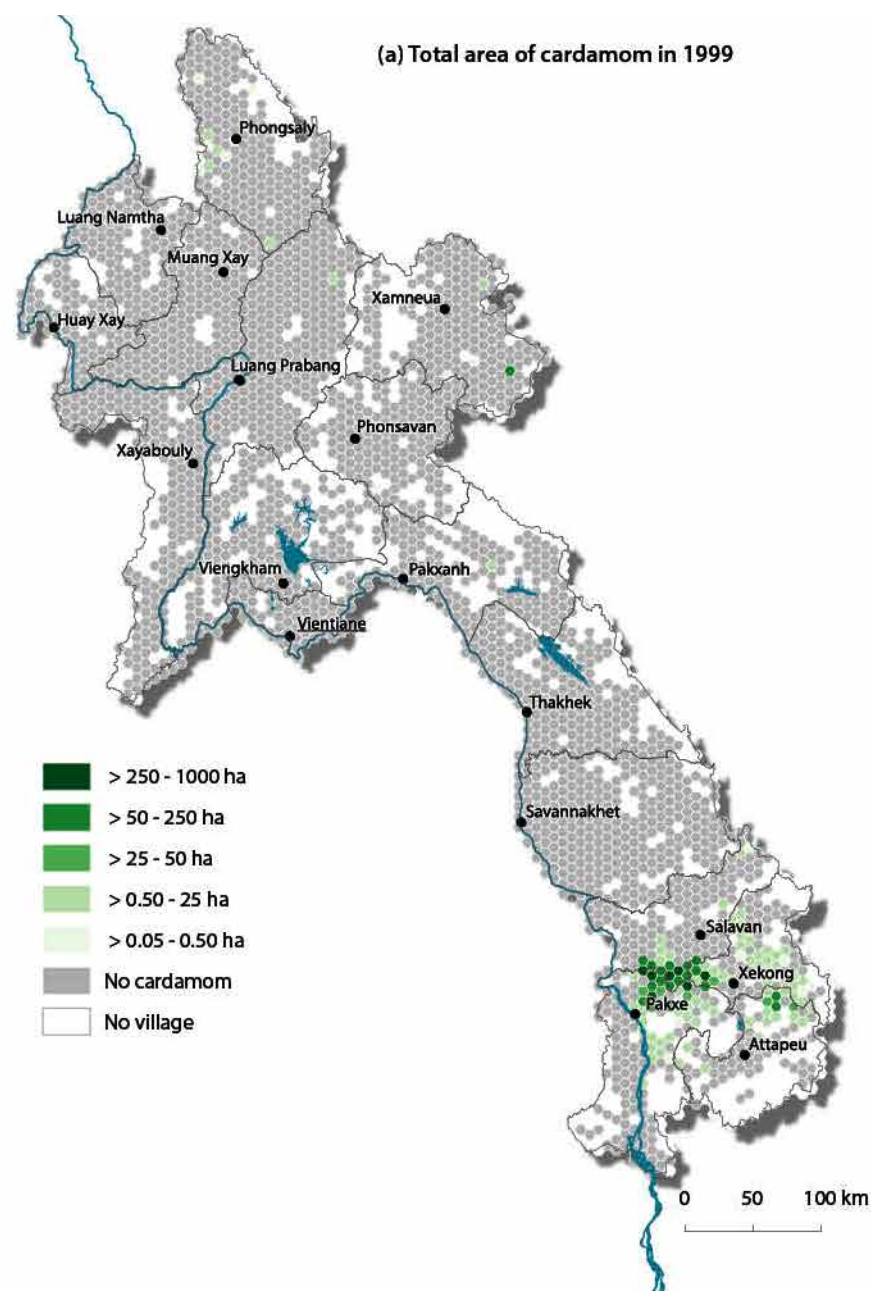
Changes in cardamom cultivation patterns between 1999 and 2011

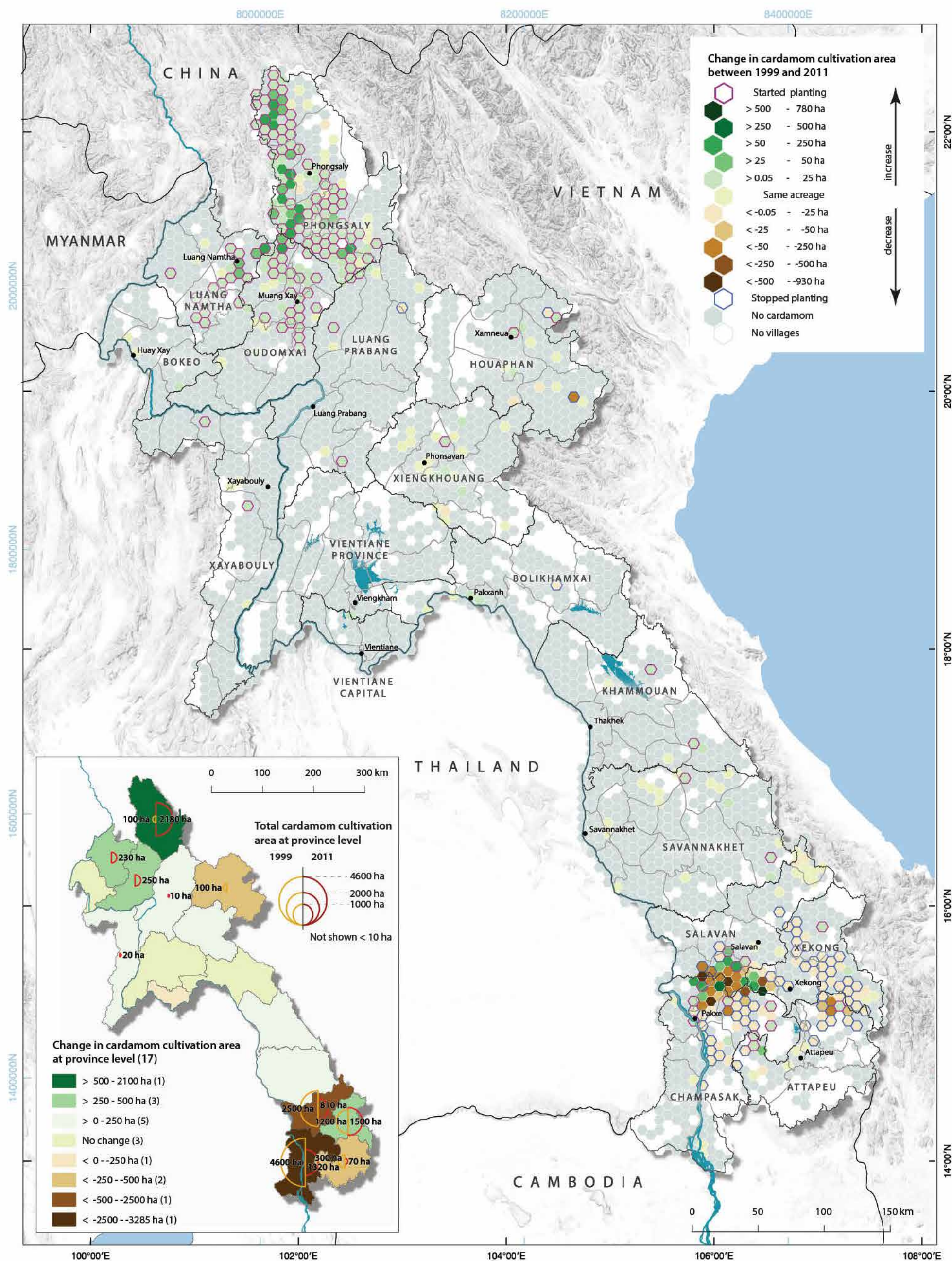
The cardamom cultivation area decreased from 8,813 ha in 1999 to 6,427 ha in 2011. While cultivating cardamom in the north is mainly new, cardamom has been grown around the Bolaven Plateau since before 1999. In the south, the area devoted to cardamom decreased by more than a half, from over 8,000 ha in 1999 to less than 4,000 ha in 2011. The overall increase in cardamom cultivation in the north therefore does not outweigh the significant decrease in production in the south. Overall, the area under cardamom production in the Lao PDR has decline by 27 percent in the last decade.

Interpretations

Cardamom in the Lao PDR is mostly produced under agro-forestry systems. There is high market demand for cardamom and decent prices paid to producing households by local collectors or trade partners in neighbouring countries. Still, due to the strong promotion of commercial cash crops such as rubber (see C20) and coffee (see C21), the overall cardamom production area has decreased over the past 10 years.

The decline in production area in the south was caused by low prices for Pakxong cardamom – the variety primarily grown there – as well as for wild cardamom. High transportation costs from Champasak to China, the main market, also make cultivating cardamom in the south less attractive. An important driving force for the increase in cardamom producing area in the north is the establishment of various rural development projects by both the GoL and international development agencies attempting to scale up cash crop production, especially for crops like cardamom which can be grown organically and have clear market demand.





C24 Tea

Introduction

Tea (*Camellia sinensis*) is one of the most popular aromatic beverages in the world. The world's oldest tea was 3,200 years old and was found in the Fengqing County of Yunnan Province in southwestern China, which neighbours the Lao PDR (Heiss and Heiss, 2007). Tea production started in the Lao PDR in two different periods and regions. First, northern Lao PDR produced tea around 600 years ago and the connection of the Lao tea trade with China was recorded as far back as the 7th Century. Second, in 1920, the French colonial government brought tea into the Lao PDR from central Vietnam to the fertile volcanic soils of the Bolaven Plateau in Champasak.

There are three main categories of tea plants: wild forest tea, cultivated forest tea (locally known as “ancient tea”) and commercially cultivated tea. The wild and the cultivated forest tea plants are mostly grown in the north, particularly in Phongsaly, while commercially cultivated tea is more commonly grown in the southern provinces.

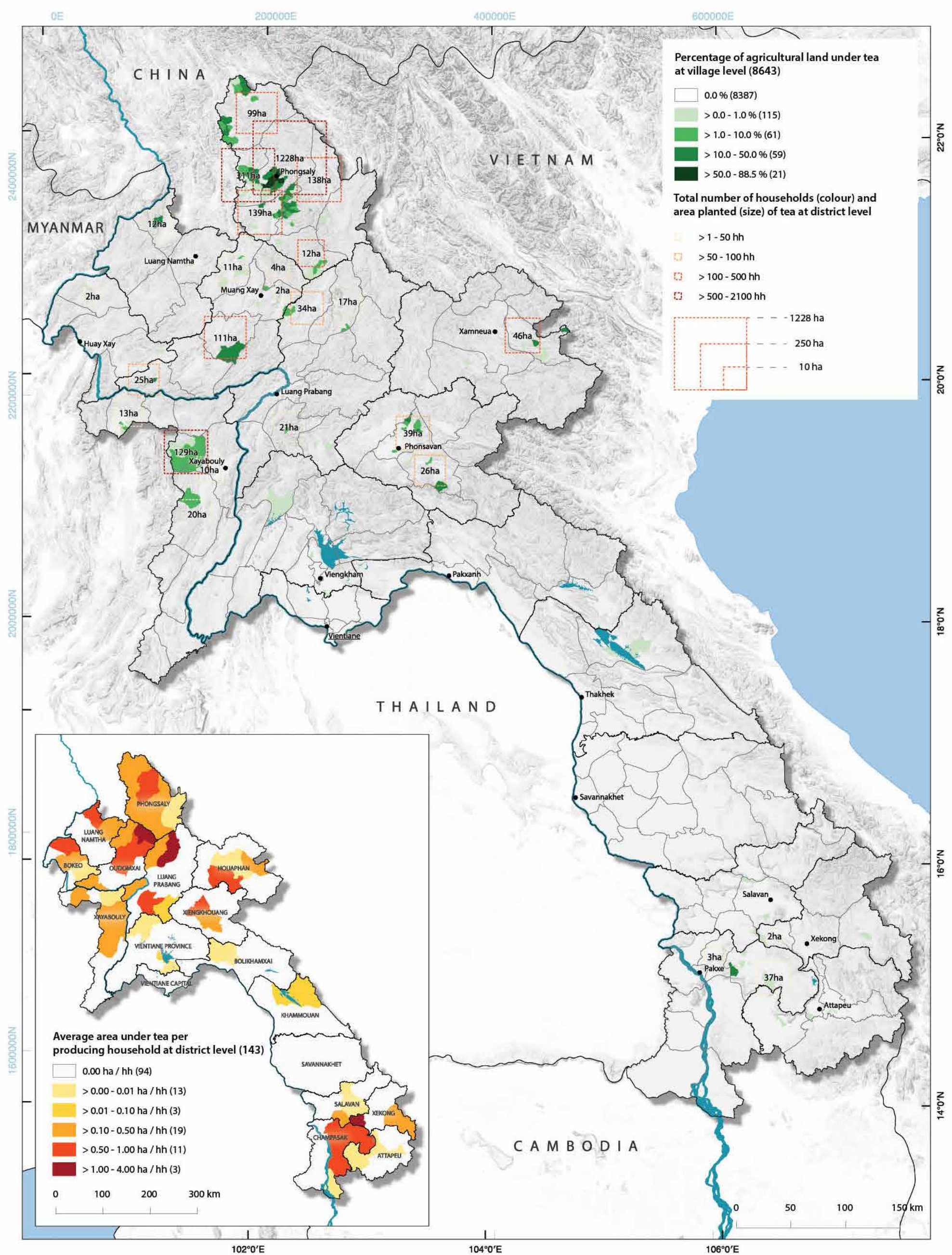
Despite the crop’s long history, the Lao tea sector is relatively underdeveloped in comparison to its potential. As tea cultivation is one of the main agricultural activities of many ethnic minorities and particularly women in remote and rural communities in the uplands, tea has a great potential to contribute significantly to poverty reduction and rural development in the Lao PDR. Tea produced in the Lao PDR is mainly exported to China as Lao tea leaves are highly valued on the Chinese market.

Patterns of tea cultivation in 2011

Overall, 2,497 ha of tea is cultivated in the Lao PDR, of which around 95 percent is in the north. The main map shows that the main tea areas are located in Phongsaly, Xayabouly (Xaisathan District) and Oudomxai (Beng and Pakbeng Districts). In each of these provinces there is at least one district where more than 100 ha of tea are grown. In Phongsaly District, Phongsaly Province, 1,228 ha are cultivated by 2,100 households. Tea is also cultivated in Xiengkhouang, around the province capital of Phonsavan. Women from various ethnic groups such as Khmu, Lao Tai, Prai, Akha, Hmong, Tai Lue and Hor are most commonly engaged in hand picking the tea leaves.

In Phongsaly, roughly 5 percent of the total agricultural land is devoted to tea cultivation. 21 villages there use more than 50 percent (up to 88.5 percent) of their agricultural land for tea. In total, there are 6,205 households in the Lao PDR cultivating tea, of which 74 percent are in Phongsaly, 15 percent in Xayabouly and 4 percent in Oudomxai.

As the inset map shows, tea production on small plots of less than 1 ha on average is observed in 46 districts. Three districts in Oudomxai, Luang Prabang and Xekong Provinces, namely La, Ngoy and Thateng Districts, cultivate tea on an average area greater than 1 ha and up to 4 ha per household.



Changes in tea cultivation patterns between 1999 and 2011

In 1999, about 80 percent of the area devoted to tea (1,339 ha) was in the south, while the north was home to the remaining 20 percent. The total tea cultivation area has continuously decreased in the south, especially in Champasak. Many agricultural households there have abandoned tea cultivation for other crops with higher economic benefits. As a consequence, over 96 percent or about 1,025 ha of tea has been abandoned or left unmanaged.

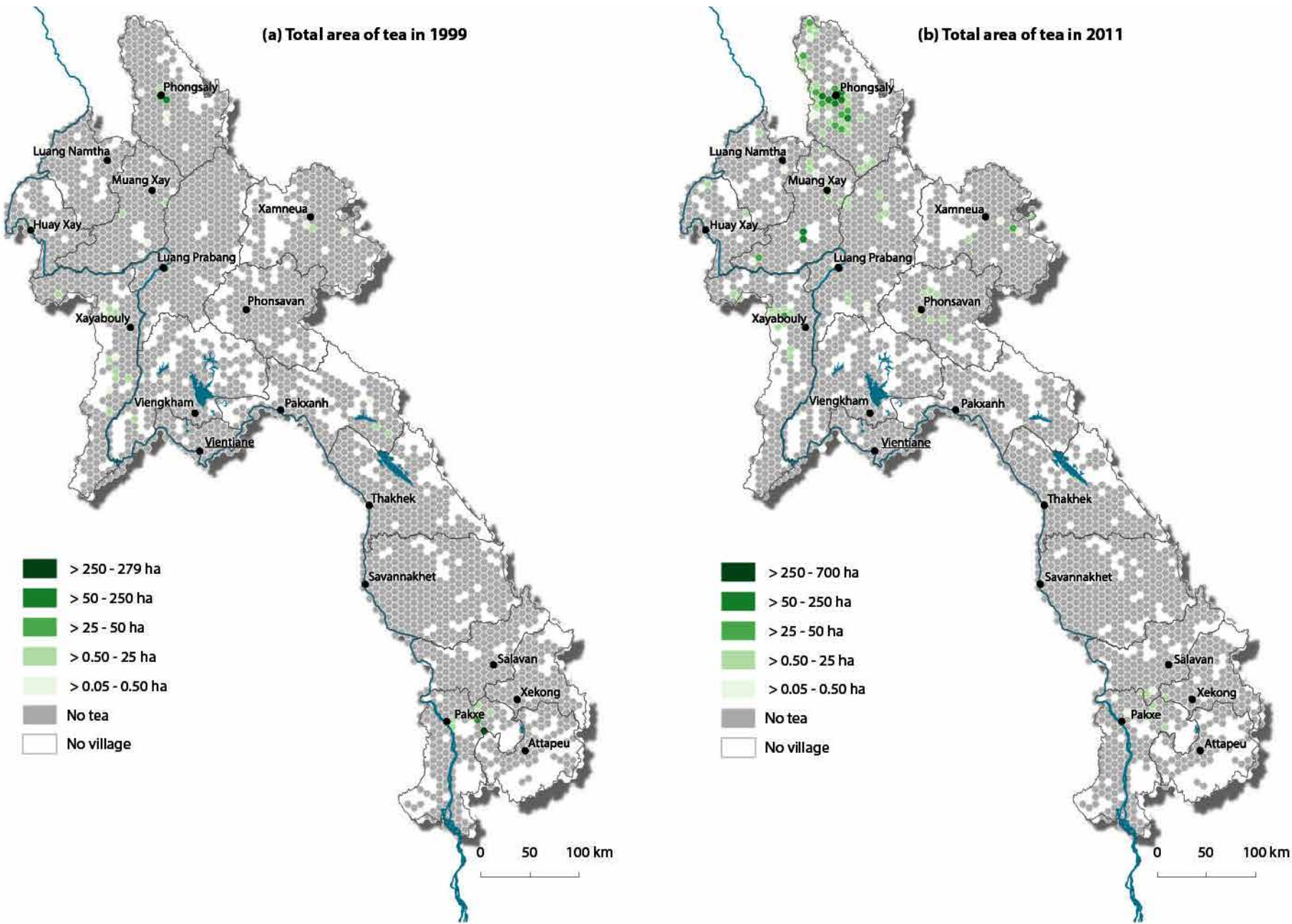
Despite the decrease in tea production in Champasak, the overall cultivation area has almost doubled. Phongsaly has experienced an eleven fold increase from 174 ha in 1999 to 1,928 ha in 2011. The tea cultivation area in Oudomxai and Xayabouly also increased by 150 ha and 120 ha respectively during the same period. Along with this increase in area under tea, over 4,000 more households are engaged in tea cultivation (from 2,041 households in 1999 to 6,205 in 2011). The highest increase in tea cultivating households occurred in Phongsaly, whereas the highest decline was recorded in Champasak over the same period.

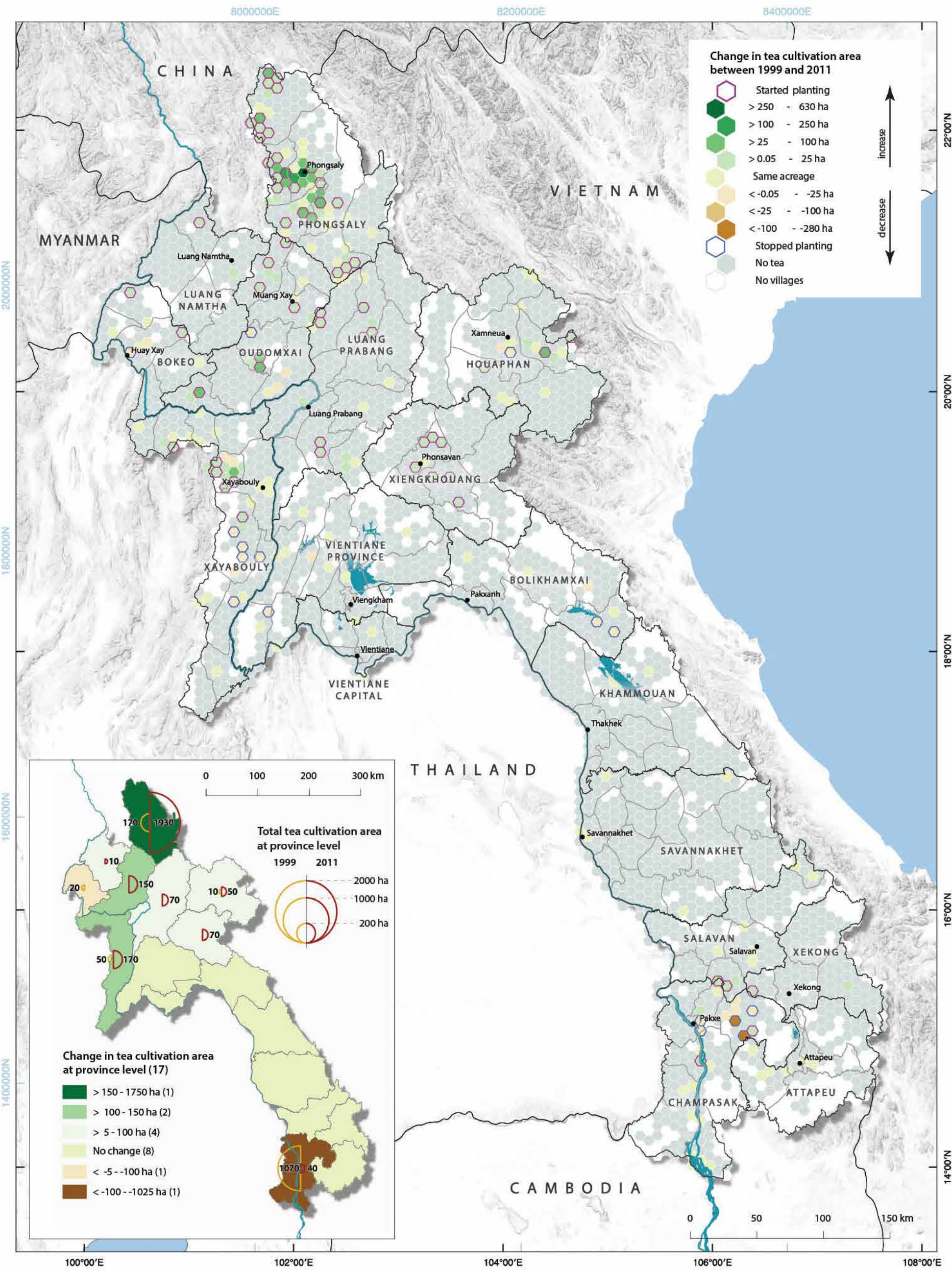
Interpretations

Tea production in Champasak drastically dropped between 1999 and 2011 for a number of reasons. First, as the coffee price went up, farmers in the south have become more interested in planting coffee than tea. Many tea trees have not be picked or actively managed for production for years as a result. There has also been an issue of labour shortage caused by labour migration to administrative centres and neighbouring countries (mainly Thailand), which has negatively affected the domestic agricultural sector more broadly in the Lao PDR. Finally, despite high demand from China for Lao tea, tea prices in the south do not compare with those offered to farmers in the north. This difference is mainly due to high transportation costs from the south and Chinese buyers' preference for northern Lao tea.

Various programs supporting smallholder farmers have been initiated by the GoL and international donors, including a range of poverty eradication and sustainable livelihood programs targeting the rural poor in remote upland communities where tea is often a preferred crop.

The high market demand for tea, coupled with the scarcity of land for tea cultivation in China, has led to dramatic price increases, particularly for northern provinces where Chinese tea companies have expanded their own tea cultivation areas, while also providing some technical support to smallholder farmers, often in partnership with provincial government authorities. The expansion of market opportunities for tea in these areas has contributed to local economic growth, sometimes benefitting households engaged in tea production.





C25 Mango

Introduction

Mango (*Mangifera indica*) is a fruit tree grown throughout the country for household consumption as well as for sale. Many local varieties of mango are planted in the Lao PDR, referred to in Lao language as *Muangpar, Kasor, Kasen, Muangnang, Muangkeo, Oklong, Ngaxang*, and *Muangkhai*. However, growers are interested in planting new varieties, especially those with strong market demand such as *Khiaosawoei, Namdokmai, Nangseam, Falan, Choko Anan, Maha Chank, Nangkhanvanh, Thongdam, Salaya, Chokhounthip* or *Norred*. Mango is eaten both green (under ripe) and ripe in the Lao PDR.

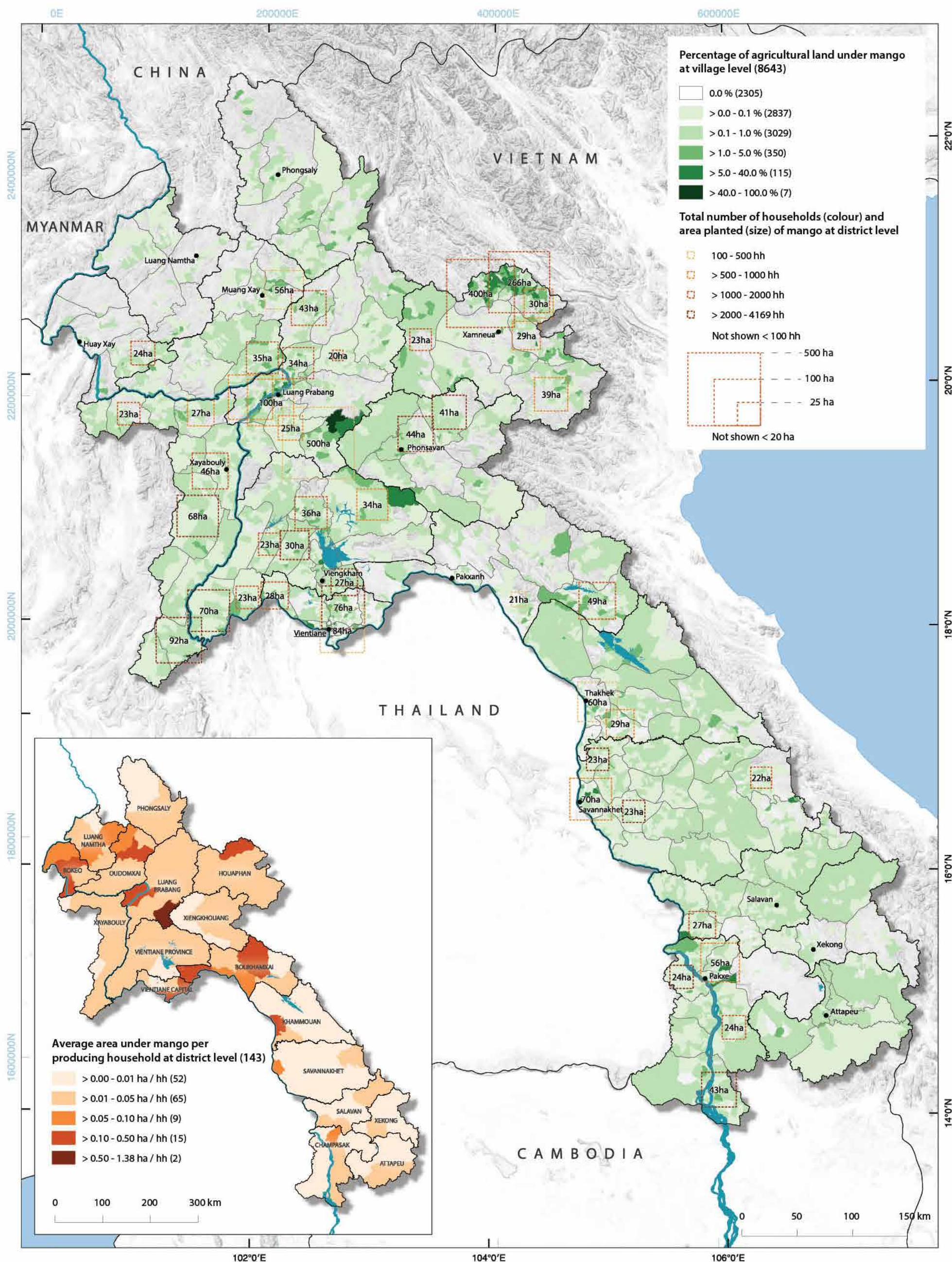
Patterns of mango cultivation in 2011

There are 3,955 ha of mango planted by 184,800 households across the Lao PDR. Most villages grow mango but use only a fraction of their agricultural land for it – often there are just a few mango trees in a village – while only 27 percent of all agricultural villages do not grow mango at all. In Phoukhoun District, Luang Prabang Province, 500 ha of mango is cultivated by 438 households. In Houaphan, the two very northern districts bordering Vietnam, namely Et and Xiengkho Districts, also stand out with 400 ha and 266 ha of mango under cultivation, but here it is cultivated by 1,976 households and 1,988 households respectively.

The inset map shows that mango is actually grown in all districts but in many districts households only grow a few square metres of mango on average. Especially from Khammouan to the far south of the Lao PDR, in western Xiengkhouang, and in Phongsaly, the average area per household is small. The highest average areas per household are found in the above mentioned districts of Phoukhoun in Luang Prabang Province and in Chanthabouly District in Vientiane Capital.

Table 7: Total and change of mango area between 1999 and 2011

Province	Total ha mango 1999	Total ha mango 2011	Change 1999 to 2011
Vientiane Capital	1,083.8	209.2	-874.6
Phongsaly	54.4	54.0	-0.5
Luang Namtha	72.3	42.3	-30.1
Oudomxai	200.7	148.5	-52.3
Bokeo	865.8	34.6	-831.2
Luang Prabang	2,167.3	856.9	-1,310.4
Houaphan	1,545.4	817.6	-727.8
Xayabouly	842.2	363.8	-478.4
Xiengkhouang	265.9	135.2	-130.7
Vientiane	215.5	293.0	77.6
Bolikhamxai	277.2	118.2	-159.0
Khammouan	481.0	195.8	-285.1
Savannakhet	435.5	298.6	-136.8
Salavan	189.5	120.0	-69.5
Xekong	28.7	19.6	-9.1
Champasak	442.0	205.0	-237.0
Attapeu	33.3	42.5	9.2
Total	9,200.5	3,954.8	-5,245.8



Changes in mango cultivation patterns between 1999 and 2011

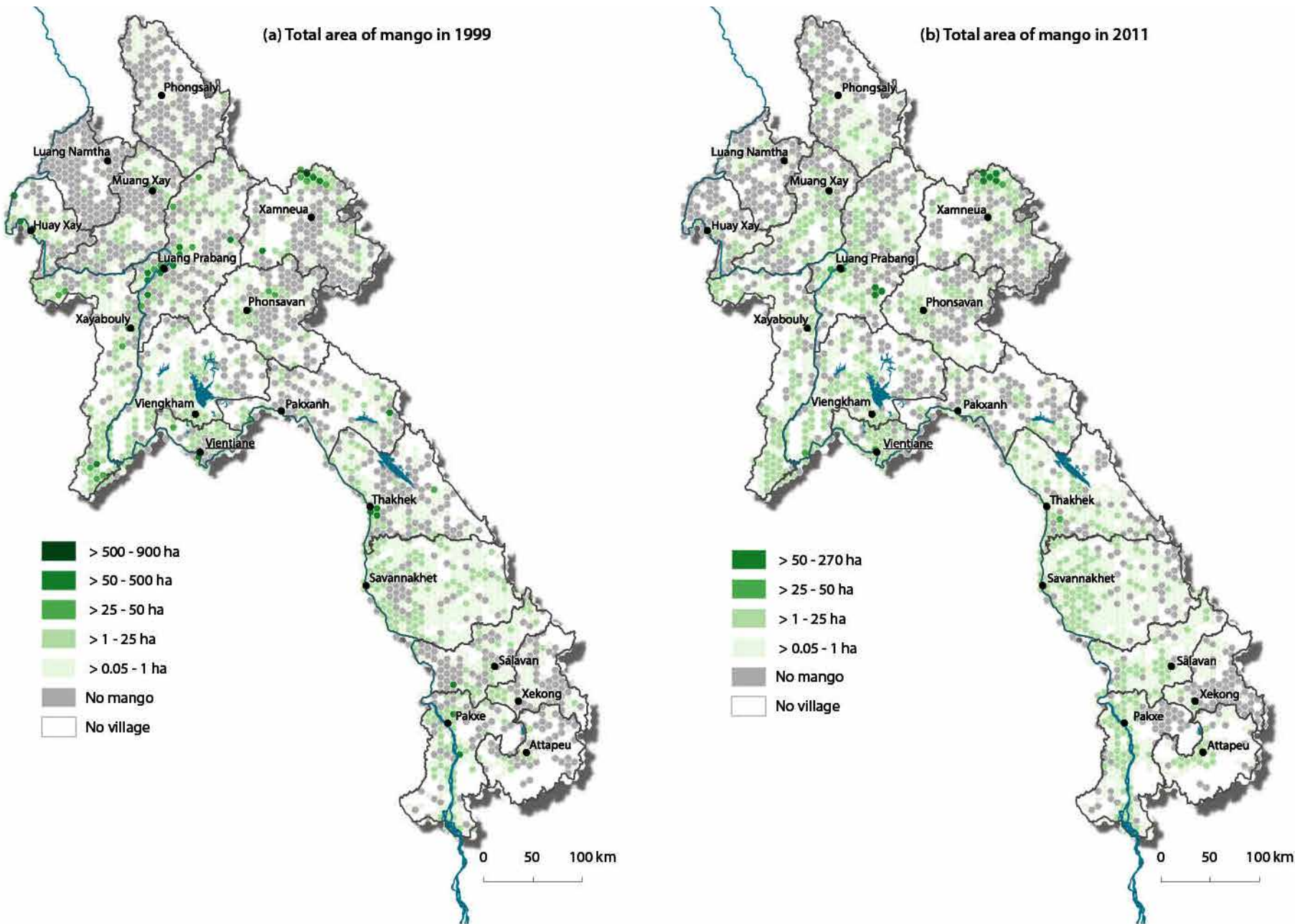
A significant decrease in mango cultivation area was recorded between 1999 and 2011 – from 9,200 ha in 1999 down to 3,955 ha in 2011. In almost all provinces, a decline is apparent, starting from only a few ha up to 1,300 ha in Luang Prabang. In contrast, only two provinces (Vientiane Province and Attapeu) experienced a slight increase in mango planting area. The mango production area in Phongsaly remained unchanged and the regions around Luang Prabang town, Huay Xay (the capital of Bokeo Province), southern Xayabouly, the suburbs of Vientiane Capital and western Savannakhet all lost remarkable areas under mango production. Table 7 gives detailed information about the mango cultivation area in 1999 and 2011 per province.

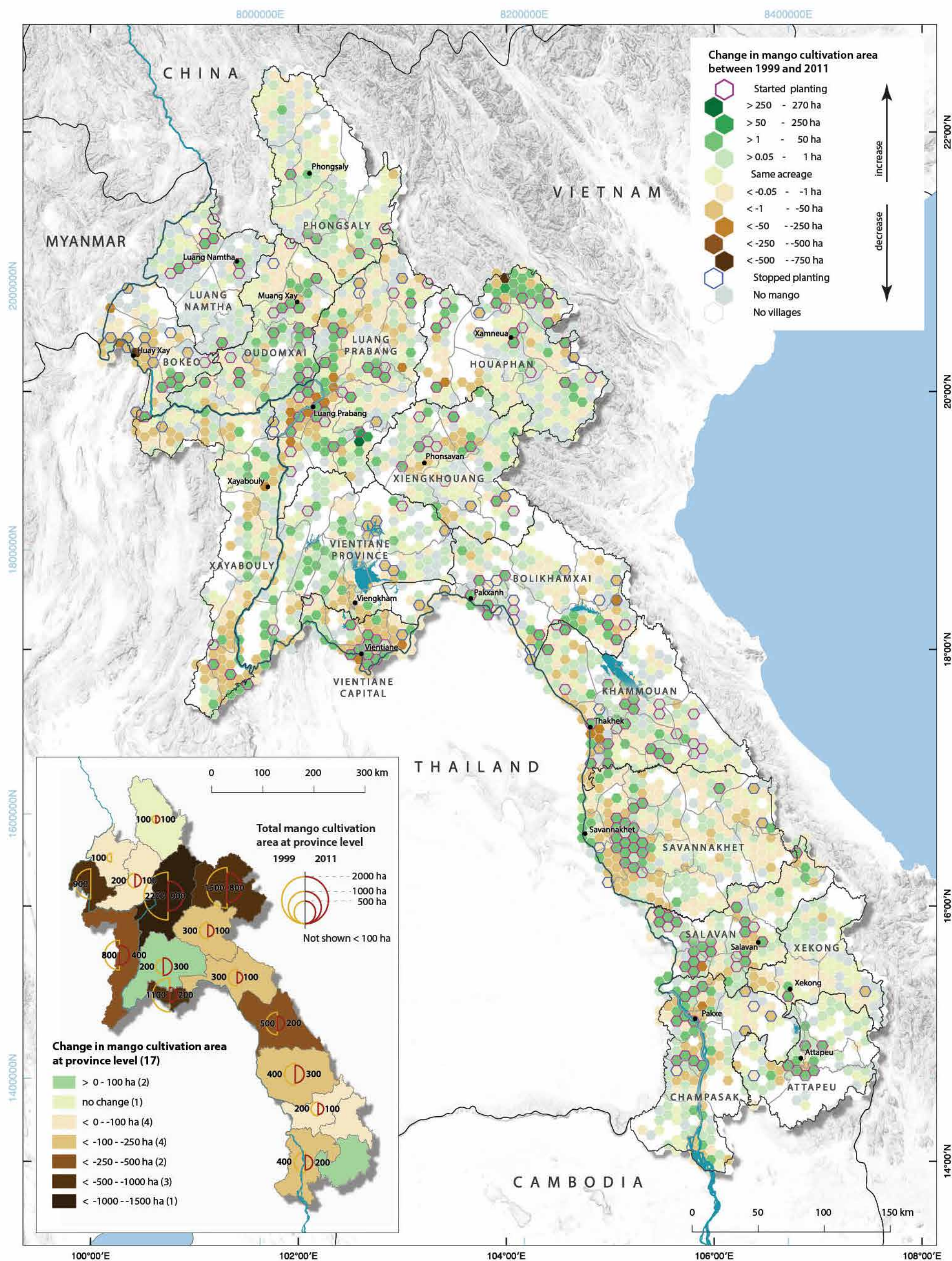
In comparison to the cultivation area, the number of households engaged in mango cultivation did not decrease so significantly. In 1999, 191,000 households cultivated mango, whereas in 2011 185,000 households still had mango trees which is only a decrease of 3 - 4 percent.

Interpretations

The reduction in areas under mango production across the country over the past decade was mainly a result of increased imports of mangoes from Thailand, which has increased competition on the domestic mango market. Anthracnose (a fungal infection) is the most common disease threatening mango trees, and its rising occurrence in the Lao PDR was another cause for the drop in the mango cultivation area. Moreover, declines in Luang Prabang, Houaphan and Bokeo were due to cold weather in some past years which, because mango trees prefer frost-free tropical and warmer subtropical climates, killed off or damaged some mango cultivation areas.

The lack of standardization of local mango seeds used and the mostly organic production in the Lao PDR, lead to a high diversity of mangoes produced. On the other hand it leads to low productivity and inefficiencies in management of pest invasions. A lack of engagement in producing during the off-season as well as poor post harvesting technologies have all put Lao mango farmers at a competitive disadvantage compared to neighbouring countries, especially compared to Thailand.







LIVESTOCK

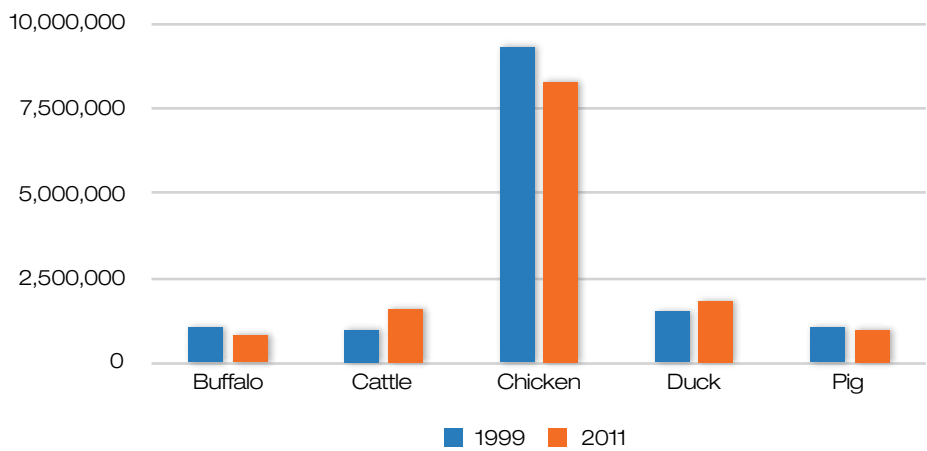
D1 Livestock overview

In the Lao PDR, livestock production is an important sector of the economy. The livestock sector, together with fisheries, contributes roughly 16 percent of the nation’s gross domestic product (GDP) and for some households it provides up to 50 percent of annual household cash income (ADB, 2005). The majority of livestock is grown by smallholder farmers in the Lao PDR and there are only a small number of commercial enterprises – engaged in pig and poultry raising – located near major urban markets. However, the demand for animal products in the region has increased significantly in the last decade. Between 1997 and 2009, total meat consumption in Southeast Asia expanded from 18 kg to 26 kg per capita per year. Consumption is expected to grow around 3 percent per year and reach 30 kg per capita in 2020 (Delgado *et al.*, 2003). The expansion of demand for meat in the region has, in turn, contributed to the enhancement of road networks and increased the income of livestock farmers across the Greater Mekong Sub-region (GMS) (ADB, 2005). The primary types of livestock raised for markets in the Lao PDR are cattle, buffalo, pigs, goats and poultry.

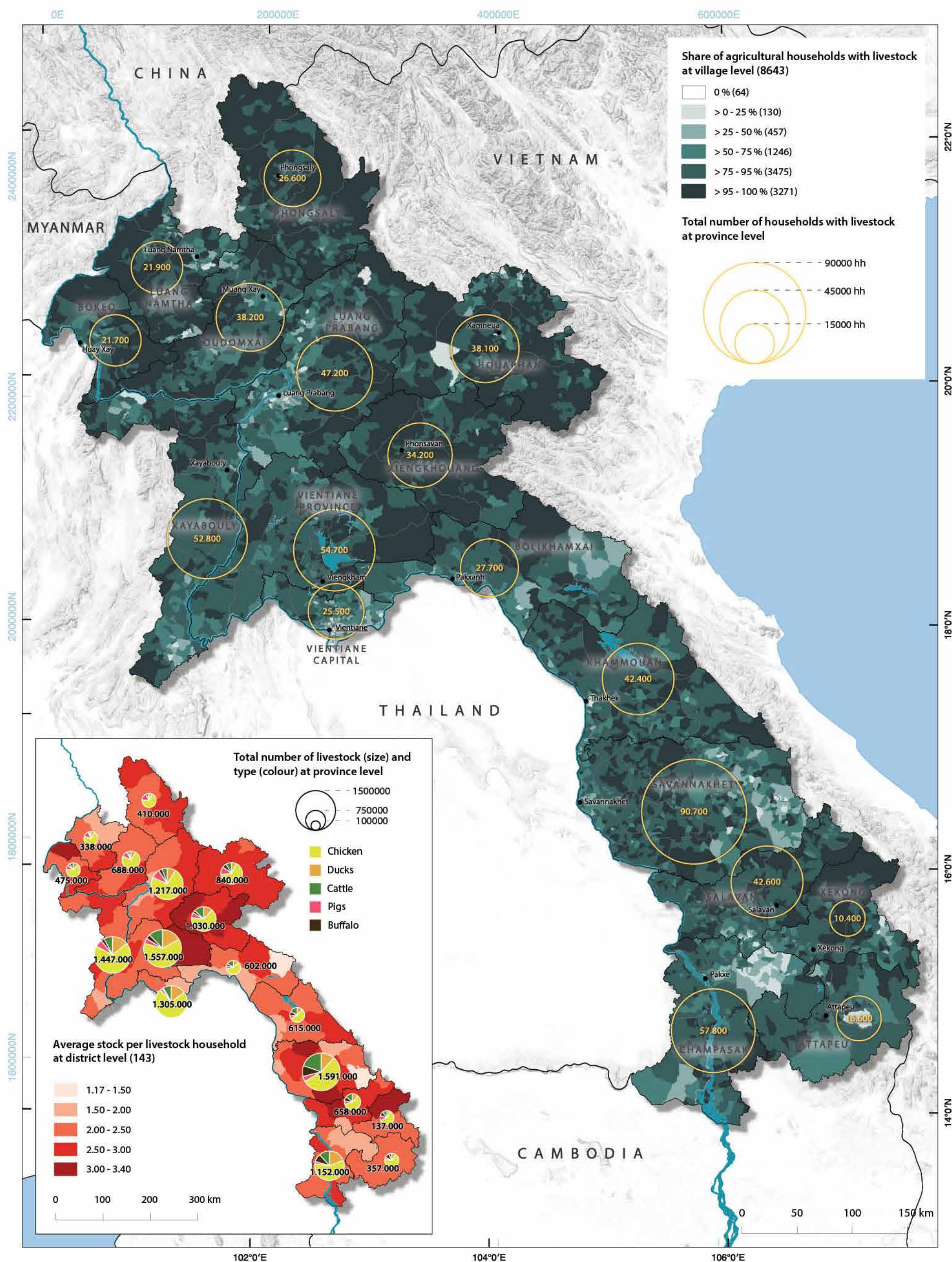
The main map illustrates the share of agricultural households with livestock at village level. Only 64 villages in the entire country do not raise any livestock, and only 130 villages reported less than 25 percent of agricultural households as raising livestock. In the Bolaven Plateau in Champasak Province, eastern Savannakhet, and the areas surrounding Vientiane Capital and Luang Prabang, the share of agricultural households with livestock is often even lower than 25 percent. The land in the Bolaven Plateau is mainly used for coffee growing and its cold temperatures do not make it suitable for livestock production. Savannakhet Province has the highest number of livestock owners with 90,700 agricultural households owning livestock, followed by Champasak with 57,800 households. In Bokeo, Attapeu and Xekong, 21,700, 16,600 and 10,400 agricultural households own livestock respectively. A few provinces with low population densities have far fewer households raising livestock, but a higher proportion of agricultural households with livestock. For example, 90 percent of agricultural households in Bokeo, 88 percent in Attapeu and 84 percent in Xekong raise livestock; these are larger shares of the total population compared to Savannakhet and Champasak, in which 82 percent and 77 percent of households raise livestock respectively.

The inset map displays the total number and type of livestock raised, aggregated at province level. Savannakhet is the top province in terms of the total number of livestock raised, followed by Vientiane Province and Xayabouly. In terms of total numbers, chicken is the most common type of livestock raised, although between 1999 and 2011 the number of chicken decreased slightly by 3.7 percent (see D6), while the number of ducks increased by 32.5 percent (see D7). Cattle raising has gained in popularity in the Lao PDR; between 1999 and 2011 the number of cattle in the country increased by 68 percent (see D4). Pigs (see D5) and buffaloes (see D3) are also important livestock for Lao farm households, although while the former decreased only slightly (-5.6 percent), the latter decreased by 22 percent between 1999 and 2011. Pigs are found in each province of the country, whereas buffaloes are more common among households in central and southern Lao PDR. Figure 7 shows the change of livestock population from 1999 to 2011.

Figure 7: Change in livestock populations between 1999 and 2011



Xiengkhouang Province and eastern Vientiane Province (especially Xaisomboun District) have the highest average number of livestock raised per livestock raising household at district level (which ranges between 3.00 and 3.40). Khamkeut District of Bolikhamxai Province and Nong District of Savannakhet Province have the lowest average number of livestock raised per livestock raising households (which ranges between 1.17 and 1.50).



D2 Variety of livestock and vaccination

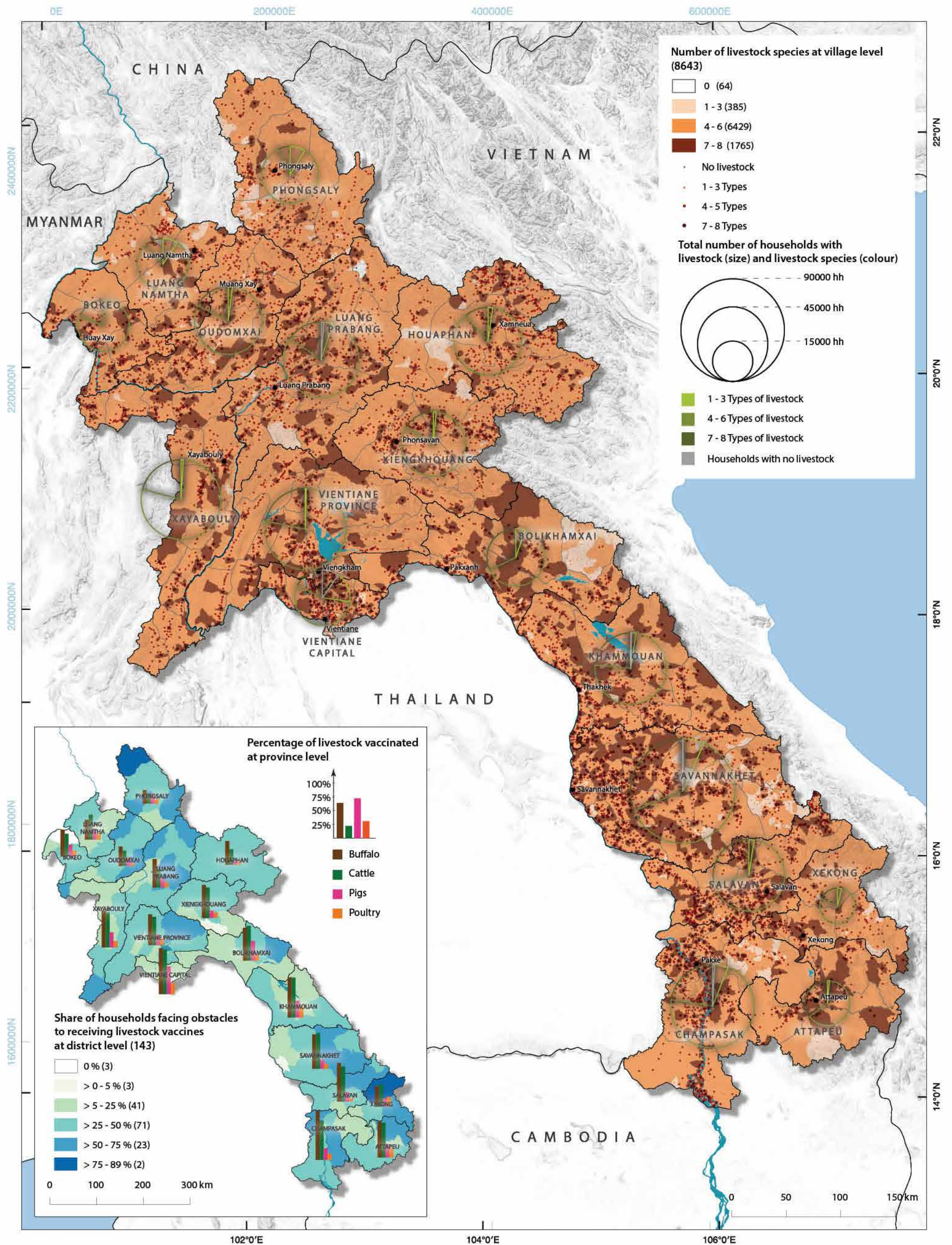
The majority of agricultural households in the Lao PDR typically treat their livestock as cash reserves and use them not solely for consumption or sale but also for ceremonial activities (Millar and Phoutakhoun, 2008; Wilson, 2007). Around 75 percent of large animals, such as cattle and buffalo, are produced and consumed locally, while the remaining 25 percent are exported mainly to Thailand and Vietnam. Among other factors, outbreaks of endemic infectious diseases greatly impact livestock raising, especially cattle and buffalo, in many Lao villages. The most common diseases among cattle and buffalo are Foot and Mouth Disease (FMD) and Haemorrhagic Septicaemia (HS). Among pigs, Classical Swine Fever and the Porcine Reproductive and Respiratory Syndrome (commonly known as the blue ear disease) are the most commonly occurring diseases. Fowl cholera, Newcastle disease and the Highly Pathogenic Avian Influenza are common among the poultry population.

Almost 90 percent of farm households own between 1 and 8 types of livestock. The main map shows the number of livestock species raised at village level. The majority of villages (74 percent) raise 4 to 6 different livestock species, while roughly 20 percent of all villages own 7 to 8 species. Villages with fewer than 3 species only constitute 4 percent of all villages in the Lao PDR. Savannakhet has the most households raising livestock, while Xekong has the fewest, though 84 percent of agricultural households in Xekong raise livestock whereas 82 percent raise livestock in Savannakhet.

Livestock vaccination rates increased substantially between 1999 and 2011 from 36 to 56 percent for cattle, 48 to 60 percent for buffalo, and 8 to 18 percent for pigs. As shown by the bar chart on the small map, households generally prefer to vaccinate large animals rather than poultry and pigs. Vaccination rates are 56 percent for buffalo, 60 percent for cattle, 18 percent for pigs, and 10 percent for poultry. In Vientiane Capital, 79 percent of all agricultural households vaccinate their cattle whereas in Oudomxai Province only 18 percent of all households do so. The lowest vaccination rate for buffalo is in Phongsaly where only 18 percent of buffaloes are vaccinated and the highest rate is in Champasak.

In northern Lao PDR, only 38 percent of farmers vaccinate their cattle compared to 63 and 62 percent in southern and central Lao PDR respectively. The same trend exists for buffalo, where 75 percent of agricultural households in the south vaccinate their buffaloes, but only 44 percent do so in the north. The regional differences in vaccination rates are less pronounced for pigs and poultry. Across regions, between 18 and 20 percent of agricultural households vaccinate their pigs, while between 8 and 13 percent vaccinate their poultry. The rate of agricultural households that vaccinate their pigs notably increased between 1999 and 2011; in Phongsaly and Houaphan Provinces the vaccination rates rose from 3 to 17 percent and from 2 to 8 percent respectively. The inset map shows the share of households facing obstacles to receiving livestock vaccines at district level. Mostly the districts with poor accessibility have high percentages, such as Gnot-ou District in the very north of Phongsaly Province or Kalum District in eastern Xekong. In 25 districts, more than 50 percent of households face obstacles to receiving livestock vaccines.

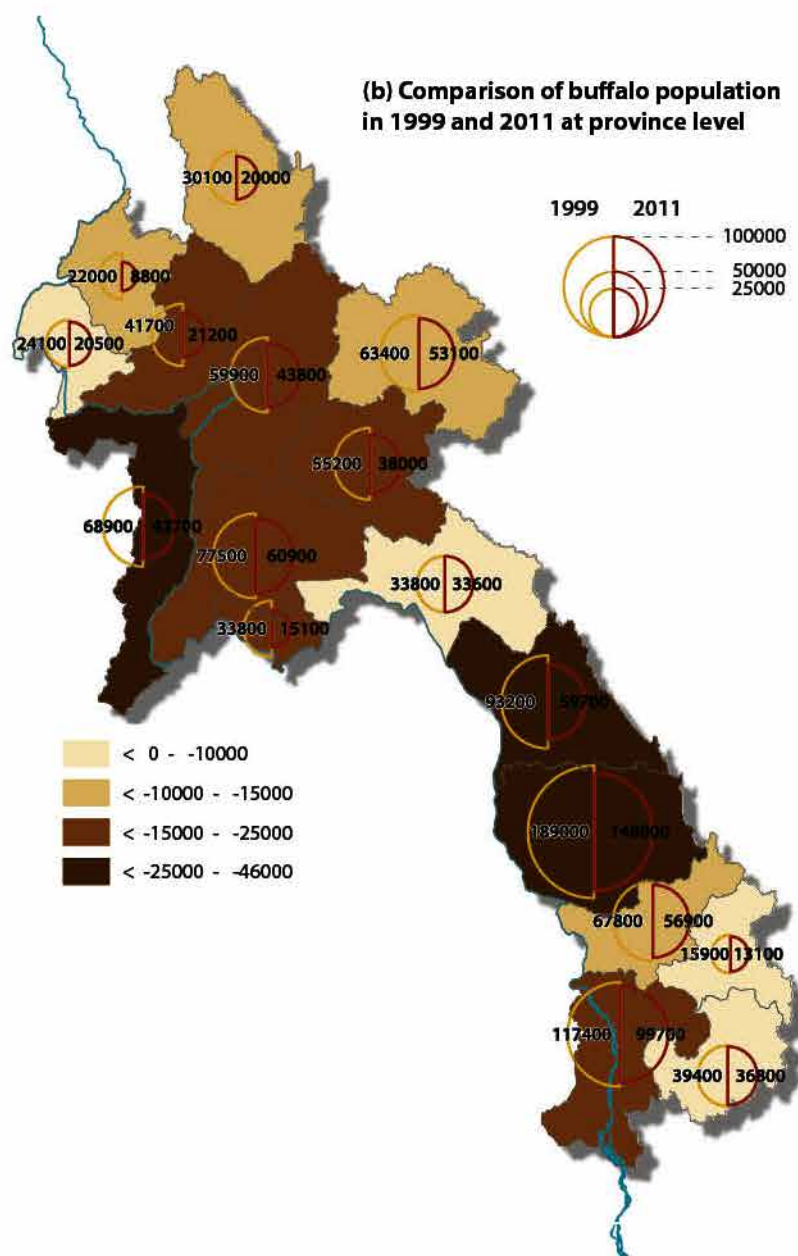
It should be noted that incidence of disease is not only an indication of low vaccination coverage but, perhaps even more significantly, a reflection of poor biosecurity practices (FAO, 2014). The concept of biosecurity refers to all the hygiene practices designed to reduce the risk of infectious diseases occurring within or being introduced into a herd or a country; it includes practices designed to control the spread of infectious agents within a herd (Larson, 2008). Having numerous native varieties raised at household or village level could be seen as an advantage as those varieties are often better adapted to local conditions and resistant to certain diseases, even if they have low productivity rates. Farmers are also typically able to breed native varieties of livestock by themselves and have relevant skills and knowledge.



In Southeast Asia, the population of the dominant swamp buffalo species declined between 1999 and 2011 by more than 5 percent. This decrease contrasts with a worldwide increase in buffalo raising by more than 17 percent during the same time span, which is due to a significant increase in populations of river buffalo throughout mainland Southeast Asia. In the Lao PDR, the buffalo population declined by around 22 percent or 217,700 animals to a total of 772,900 during the aforementioned time period. Almost one third of the overall decrease can be attributed to changes in Savannakhet and Khammaoun Provinces (29 percent combined decrease), the two central provinces with among the largest buffalo holdings. In relative figures, the decrease was most pronounced in the northern provinces of Luang Namtha (60 percent decrease), Oudomxai (49 percent decrease) and in Vientiane Capital (55 percent decrease).

percent) and Houaphan Provinces (7 percent). On the other hand, only 13 percent of buffaloes are raised in Luang Namtha, Xekong, Vientiane Capital, Phongsaly, Bokeo and Oudomxai combined. The disaggregated figures at village level reveal an uneven distribution in buffalo raising, which corresponds broadly with the main agro-ecological zones of the Lao PDR. In most of the villages in the flatland areas in the south, the majority of households still rely on keeping one or more buffalo for ploughing. High shares of households also raise buffaloes in eastern Vientiane Province, Houaphan and Phongsaly. The Bolaven Plateau area in the east of Champasak Province stands out for being almost buffalo free, which makes sense given its near total devotion to coffee and other commercial crops that typically do not require tilling or threshing.

The figures above indicate that, with a certain time lag compared to its neighbouring countries, the importance of the buffalo to agricultural activities in the Lao PDR is declining. This trend applies especially to highly accessible areas where the modernisation and mechanisation of agriculture, especially of rice production, has progressed at a fast pace. In such areas, buffalo populations are in decline as a result of shrinking demand for their draught power but also as a result of the lower economic relevance of buffalo husbandry compared to cattle, pig and poultry raising. Still, buffaloes have great relevance particularly to small-scale farmers in remote areas. Besides their importance for draught work, they still constitute an essential source of protein in the diet of agricultural households in the forms of meat and milk provision. Finally, buffaloes constitute one of the most valuable household assets.





D4 Cattle

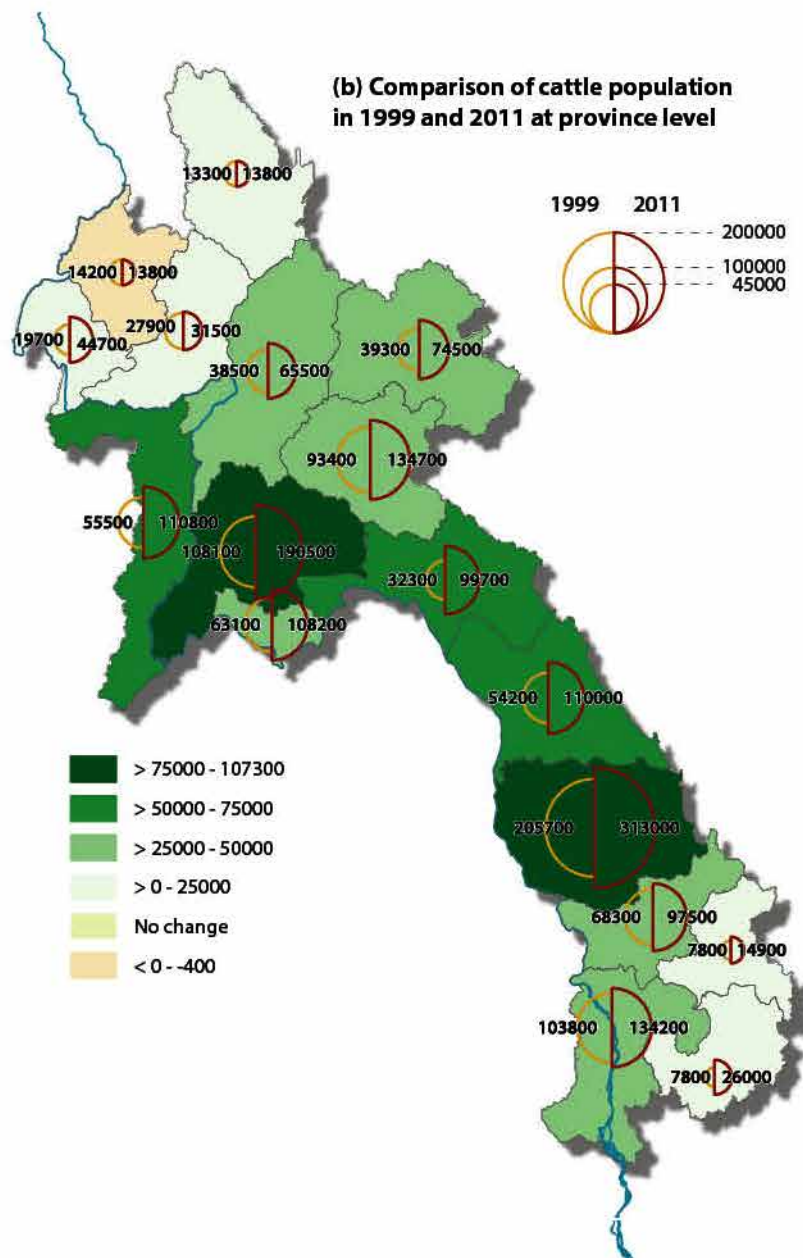
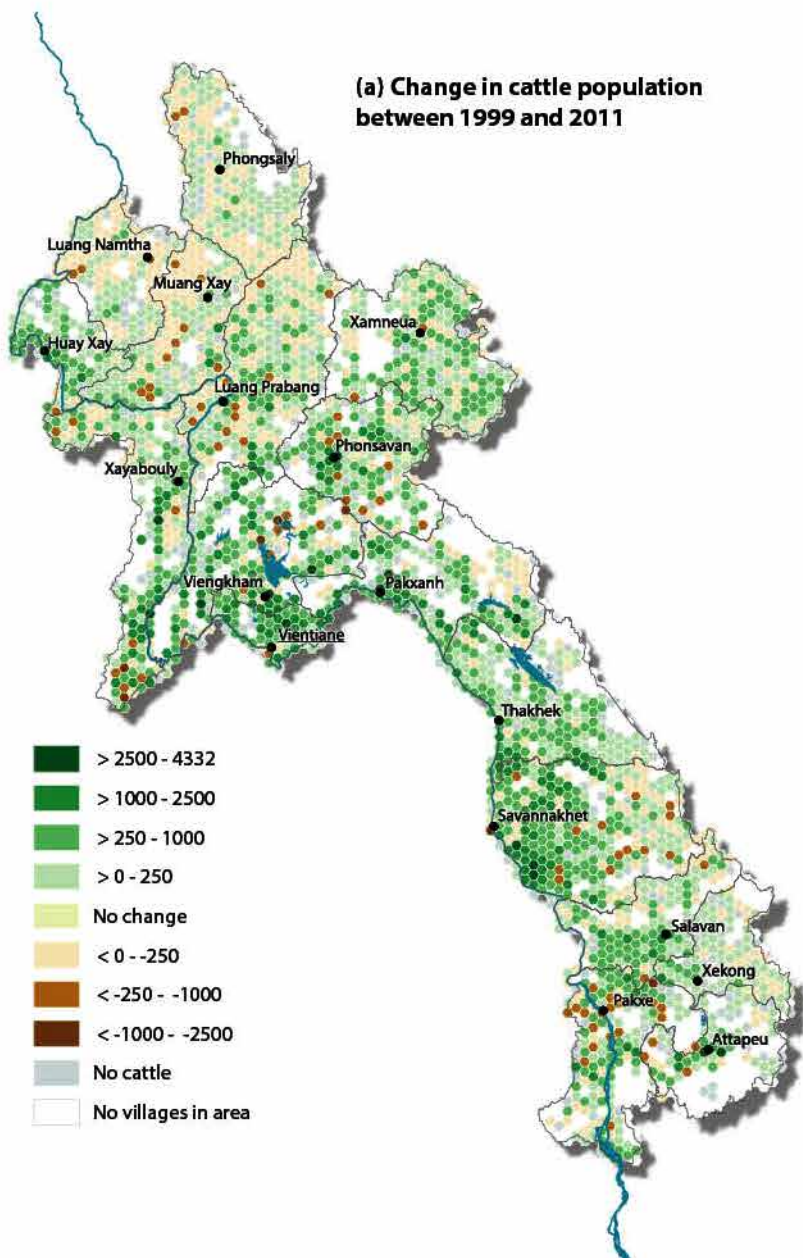
In the Lao PDR there are 1.58 million cattle, the majority of which are the Yellow Asian cattle breed (*Bos indicus*). Smallholder farmers own over 98 percent of the total cattle population. The majority of cattle production in the Lao PDR is integrated with various types of crop production systems at the household level. For this reason, farmers in the Lao PDR are often classified as ‘cattle keepers’ rather than ‘cattle producers’. The deficiency of nutritionally valuable forage, particularly in the dry season, limitations in knowledge of cattle management, and frequent infectious diseases outbreaks (e.g. of Haemorrhagic septicaemia and foot and mouth disease), have negatively impacted cattle production in the country.

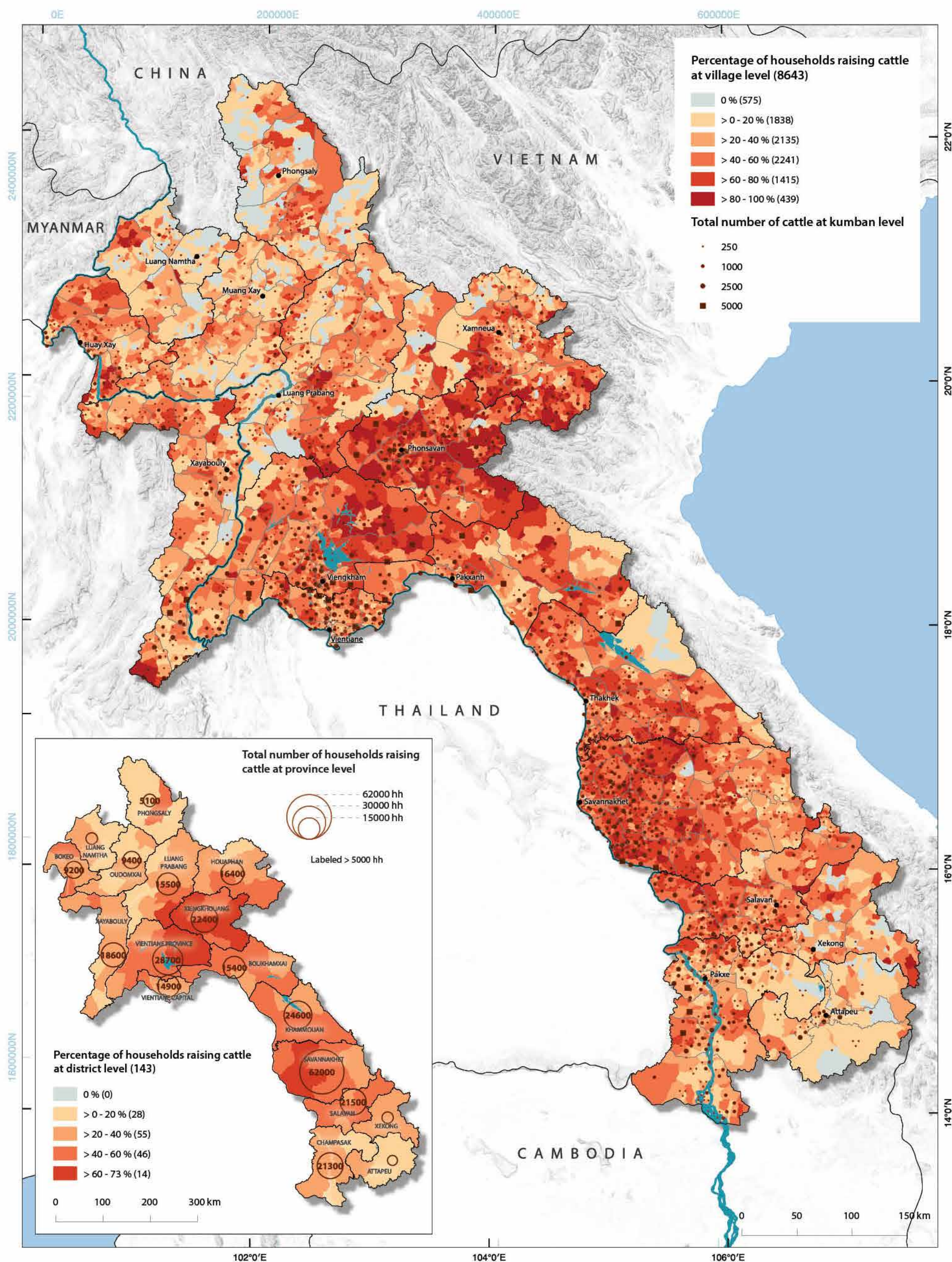
There are close to 782,000 agricultural households in the Lao PDR of which 38 percent own cattle. The percentage of cattle owners differs from region to region; in the north, 27 percent of all agricultural households own cattle, while in central and southern Lao PDR, 50 percent and 32 percent of households raise cattle, respectively.

The main map shows the percentage of agricultural households raising cattle at the village level. It can be observed that in the region in and around Xiengkhouang and also around Savannakhet town, a high percentage of these households raise cattle. In northwestern and southeastern Lao PDR, the household cattle raising rates are far lower. Savannakhet has the largest cattle population with 62,000 households raising cattle; this is followed by Vientiane Province with 28,700 households. In the provinces of Phongsaly, Luang Namtha, Xekong, and Attapeu, fewer than 5,000 agricultural households own cattle.

The comparison maps demonstrate change between 1999 and 2011, and the cattle population in the Lao PDR underwent a significant increase in all provinces except for Luang Namtha. Savannakhet and Vientiane experienced particularly significant increases of 107,300 and 82,400 heads of cattle respectively. Although small in absolute numbers of cattle raised, Attapeu experienced a 233 percent increase, the highest increase in the country.

The minimal decrease in cattle population seen in Luang Namtha and Oudomxai is linked to the rapid expansion of rubber and banana plantations in both provinces. The reallocation of land for the establishment of plantations in those provinces reduced the availability of grazing land for livestock and forced many farmers to sell their cattle. The general increase of cattle from 953,023 to 1.58 million heads (68%) across the country, in contrast, can be attributed to a range of factors including the availability of forage and large grazing areas, technical assistance from donor agencies, and increases in demand for meat by neighbouring countries (mainly China and Vietnam). Through multiple interventions by donor agencies, improvements have been made in forage quality, disease diagnosis and surveillance, and the production and distribution of vaccines.





D5 Pig

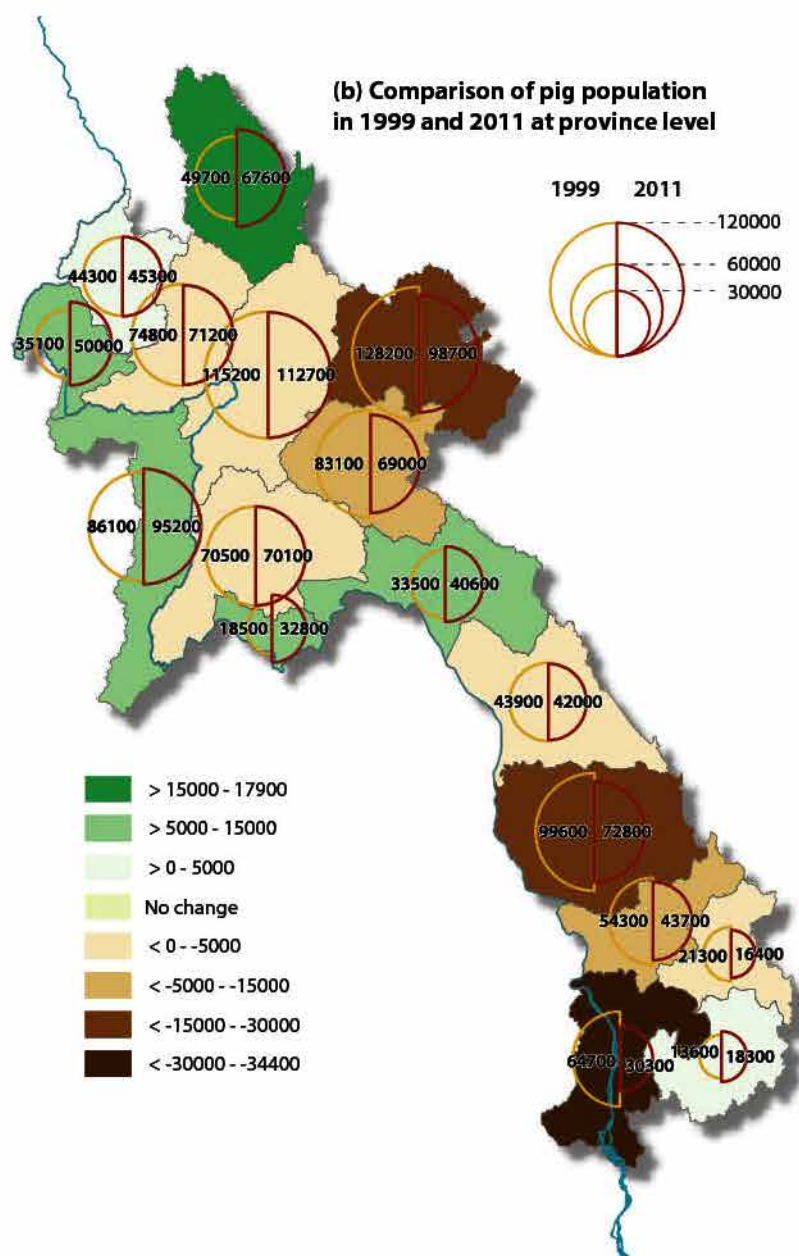
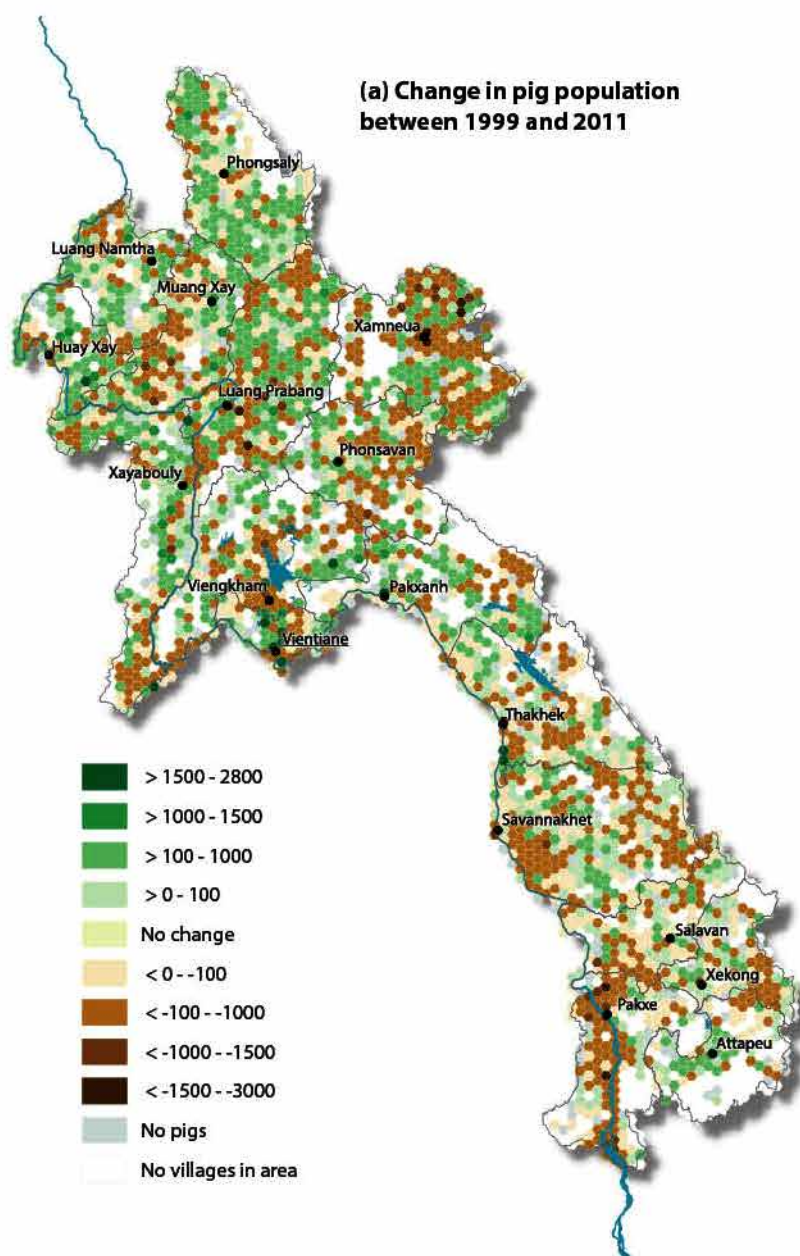
Pig production is one of the most important activities of many Lao farmers in rural areas. It is becoming increasingly important for the food supply chain, and also plays a significant role in income generation for farmers engaged in relatively low-input traditional systems of agricultural production.

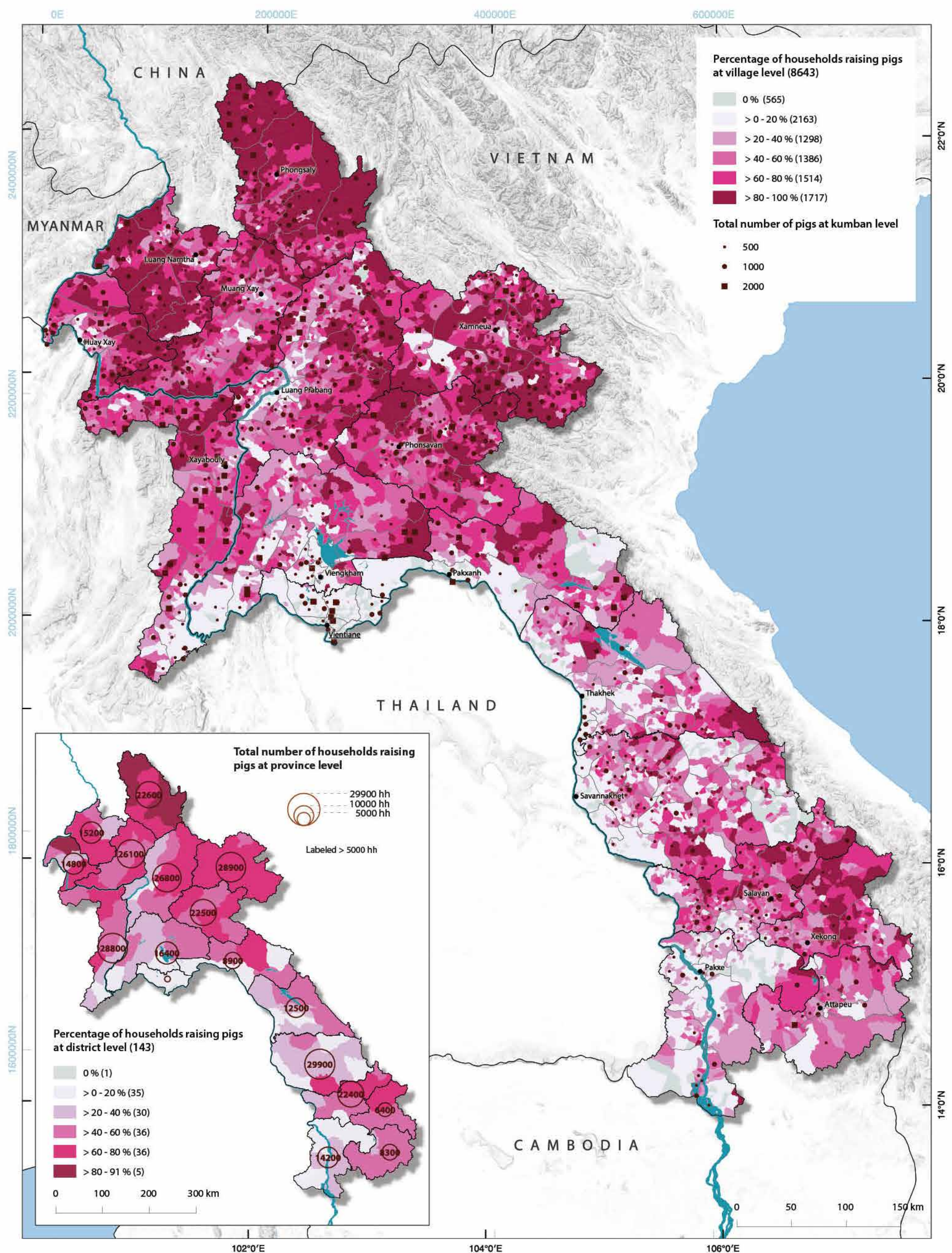
There are three main systems for pig raising in the Lao PDR: free-scavenging, semi-scavenging and year-round confinement. Under the free-scavenging system, pigs are allowed to scavenge freely for food through the whole year, receiving additional feedstuff when farmers are not working in the upland rice fields. Ethnic minorities living in remote areas commonly engage in this approach. The semi-scavenging system is used for both piglet production and fattening, and comprises of a mixture of free range scavenging and confinement. Pigs scavenge freely only after the harvesting of the main crops is finished, at which point they receive feed from their owners. This practice is common in almost all areas, particularly in Mon-Khmer and Hmong-Mien communities. The year-round confinement system is adopted in highly populated areas, particularly in Vientiane Capital and Vientiane Province. Under this system, pigs are raised in piggeries for sale on the market.

In total, there are 976,566 pigs owned by 306,600 households in the Lao PDR. About 39 percent of all agricultural households own at least one pig. 60 percent of pig raising households keep only 1 or 2 pigs, while only 5 percent have 10 or more pigs; on average, pig raising households have 3.2 pigs. As the map shows, the villages with the highest share of pig raising households are located in the upland areas; approximately 61 percent of such households are upland households while only 28 percent of lowland agricultural households raise pigs.

Overall, between 1999 and 2011, the total number of pigs declined by 5.6 percent. Provinces in the northeast and south experienced a more notable decline. The highest reductions in pig populations, in both absolute and relative terms, occurred in Champasak Province (-53 percent), Houaphan (-23 percent) and Savannakhet (-27 percent). On the other hand, the pig population increased in the northwest; Phongsaly Province, for example, experienced an increase of 36 percent in its pig population.

Declines in pig populations mainly occurred in remote areas, where poor hygiene practices and feed management cause high piglet mortality. The emergence of medium- and large-scale piggeries could be another factor that affected small-scale pig raising, making them less able to compete in the market. Increases in cash crop production and in non-farm livelihood activities have also contributed to a decrease in pig raising, especially in Champasak and Savannakhet Provinces.





D6 Chicken

Chicken production contributes to food security in many developing countries and provides income to poor farmers, especially to women. The average Lao person consumes from 30 to 40 grams of meat per day, and of these, between 8.2 and 9.7 grams consists of poultry meat. There are three main systems of chicken production in the Lao PDR: backyard extensive production with fewer than fifty birds (the most common in the Lao PDR), small semi-modern commercial production with fewer than 1,000 birds, and intensive large-scale production with over 1,000 birds. However, since local chicken production meets only a portion of domestic demand, the Lao PDR imports chicken from neighbouring countries.

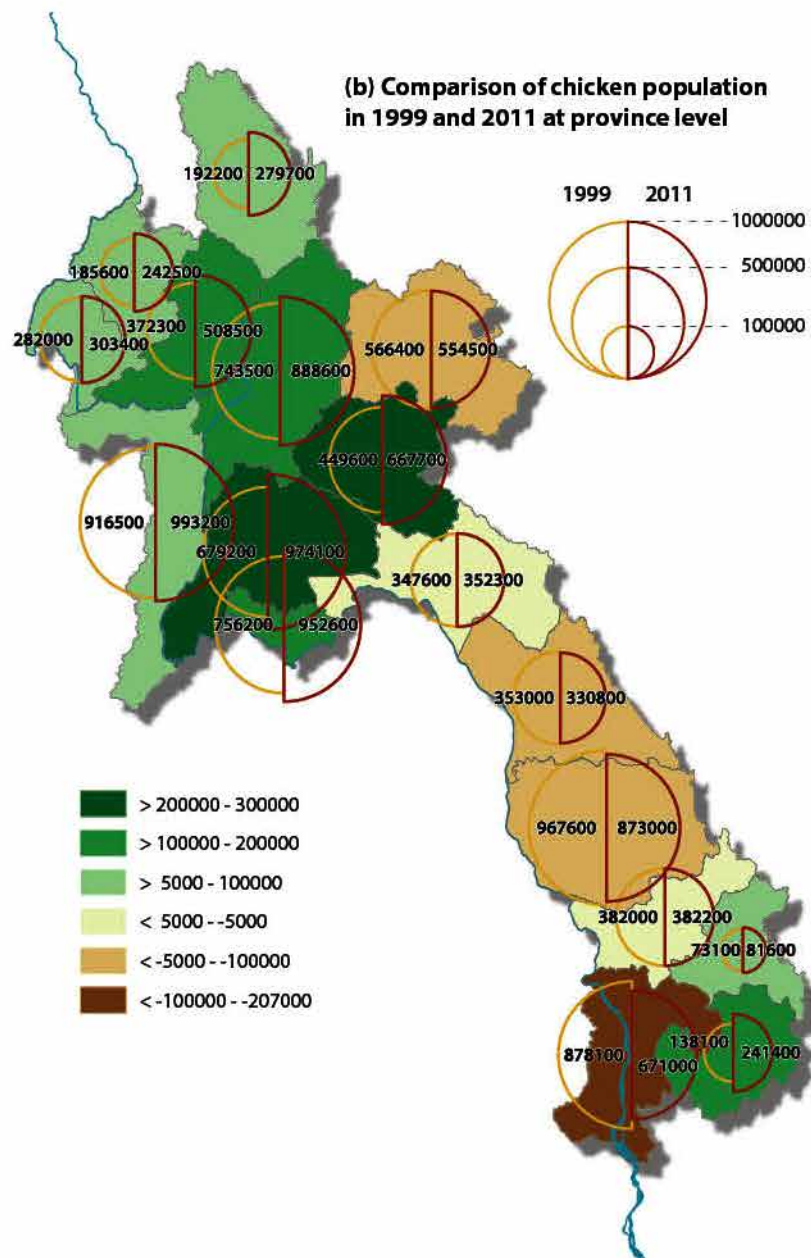
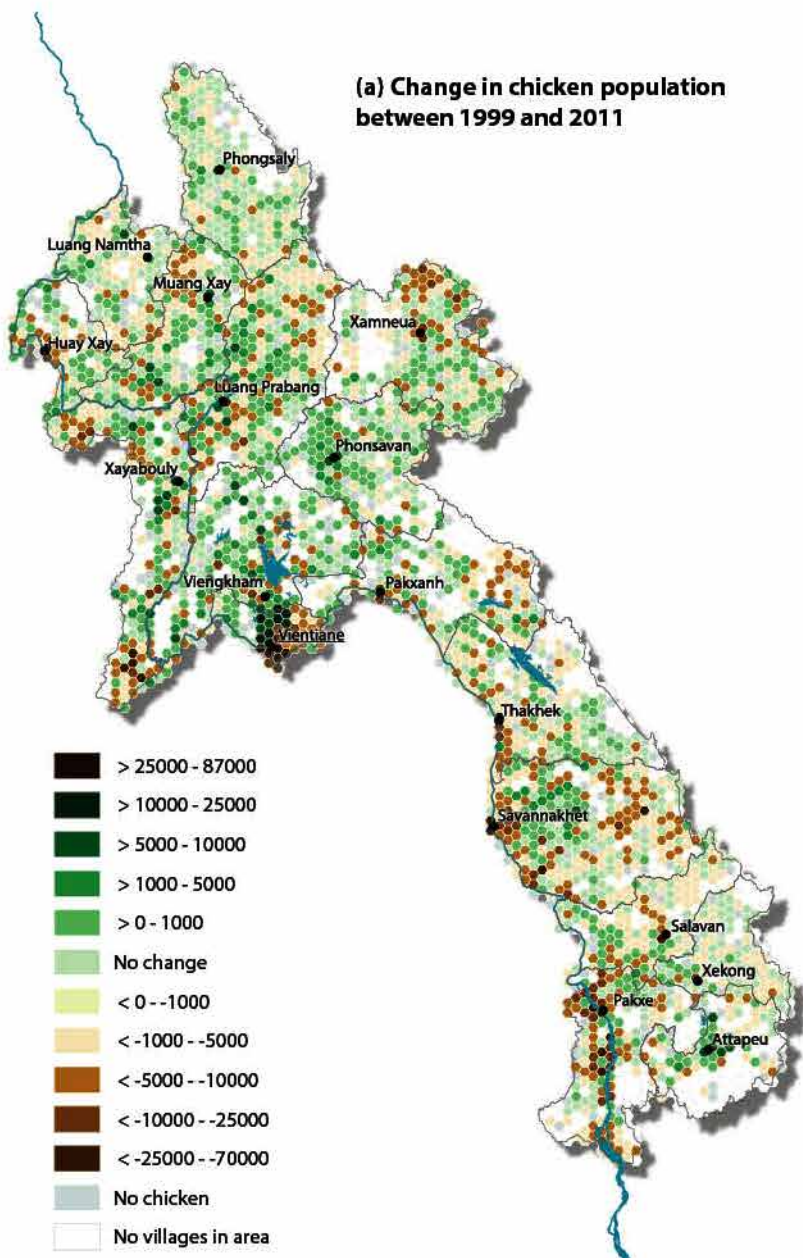
Of all agricultural households in the Lao PDR, 63 percent raise chickens, with a total of 9.3 million chickens; 93 percent of the chickens raised are local breeds. The main map shows that households raising chickens are predominantly located in northern Lao PDR, while Vientiane Capital also stands out as hub for commercial chicken breeding; indeed, two-thirds of the commercial chickens in the Lao PDR are raised there. As the main map shows, only 222 villages, mainly located in eastern Bolikhamxai, in Savannakhet, and on the Bolaven Plateau, do not engage in any chicken raising.

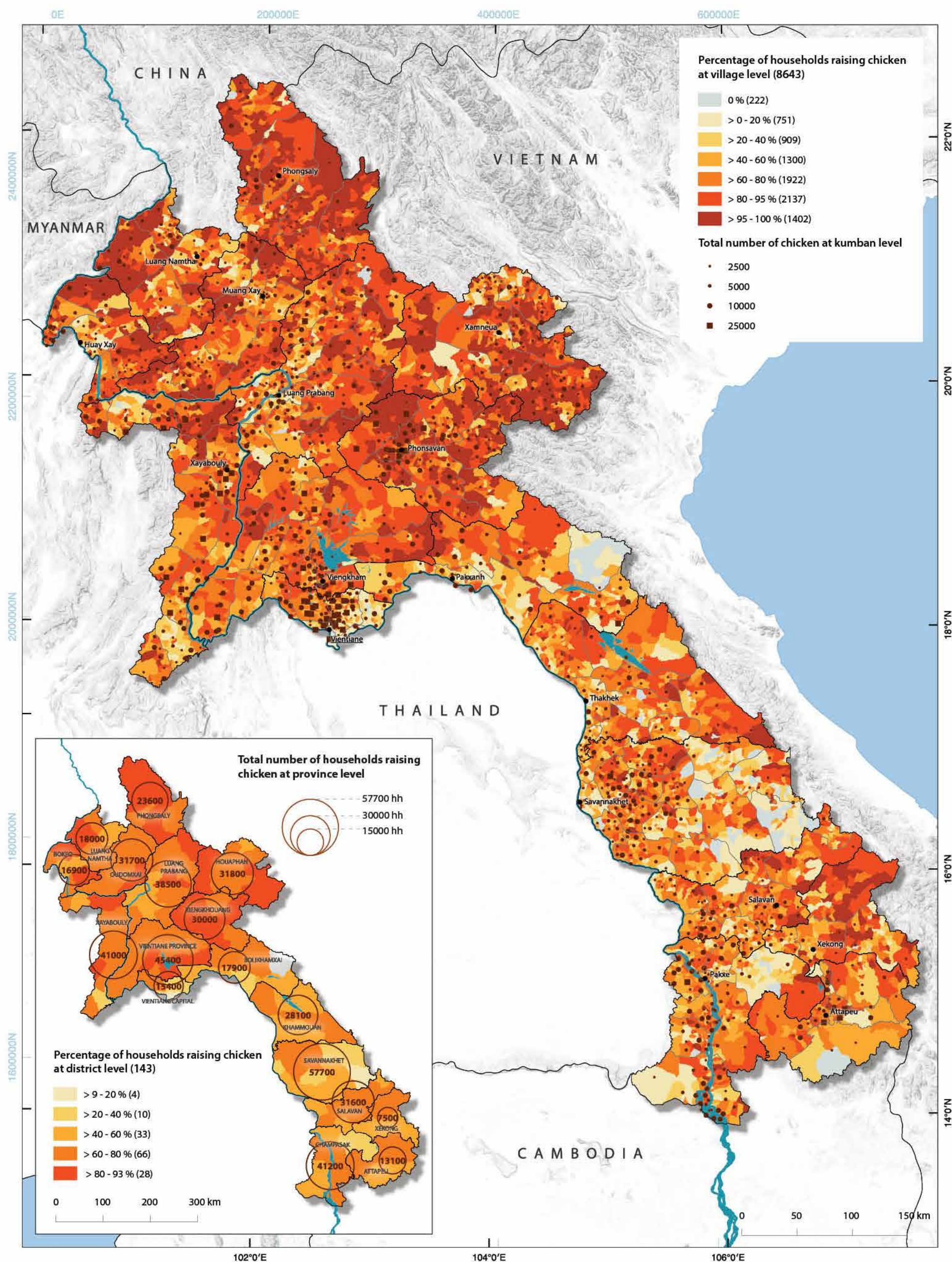
Savannakhet Province has with 57,700 households the largest number of households raising chickens, followed by Vientiane and Champasak Provinces, with totals of 45,400 and 41,200 chicken raising households respectively. However, in Savannakhet, only 58 percent of agricultural households raise chickens, while 68 percent in Champasak and 83 percent in Vientiane Province do so. In Xekong and Attapeu Provinces, 7,400 and 13,100 households, respectively, raise chickens; this accounts for 74 percent and 77 percent of all agricultural households

in each respective province. In Phongsaly Province, 23,600 households, or 90 percent of all agricultural households, raise chickens, which is the highest share of households raising chickens.

Between 1999 and 2011, the local chicken population decreased by 3.7 percent or around 1 million chickens. The increase occurred throughout the whole country except for in Champasak, Savannakhet, Khammouan and Houaphan Provinces. The number of commercial chickens increased by 124 percent or 6.9 percent per year; the vast majority (almost 84 percent) of commercial chickens are raised in central Lao PDR, mostly in Vientiane Capital where almost 470,000 commercial broiler and layer chickens (or around 72 percent of the total national flock) are raised. Commercial chicken rearing has expanded in response to increasing demand for chicken meat and eggs in urban areas. On the other hand, in Champasak Province, the chicken population decreased by 207,100 heads between 1999 and 2011, accounting for 62 percent of the whole country's overall reduction. Savannakhet follows with 94,600 fewer heads of chicken raised in 2011 compared to in 1999 (28 percent of the total decrease). Khammouan (-6.6 percent) and Houaphan (-3.5 percent) Provinces together account for 10 percent of the overall reduction.

The slight decrease of chicken is among other things due to diseases such as Avian Influenza, Fowl Cholera, and Newcastle Disease. These are important limitations to the development of the chicken industry. Limited knowledge of animal healthcare, nutrition, and management are additional complications that threaten the expansion of the poultry industry.





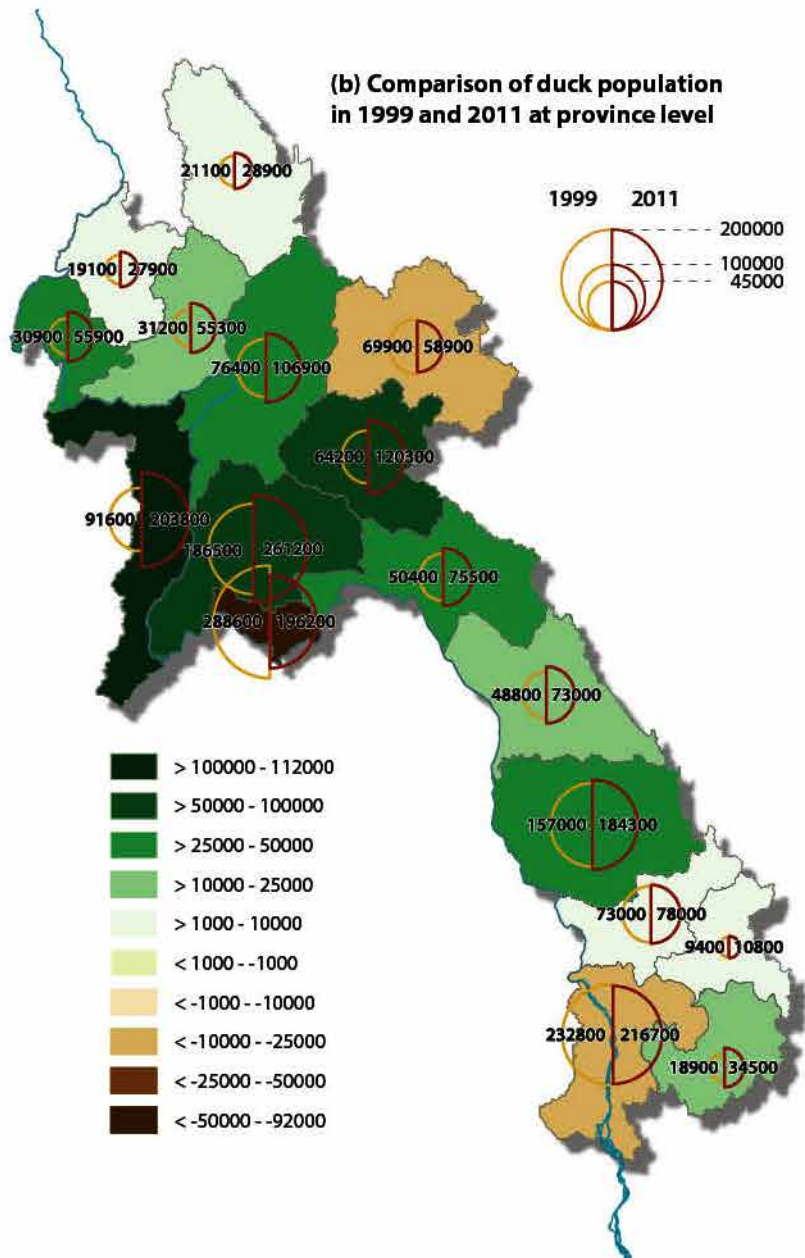
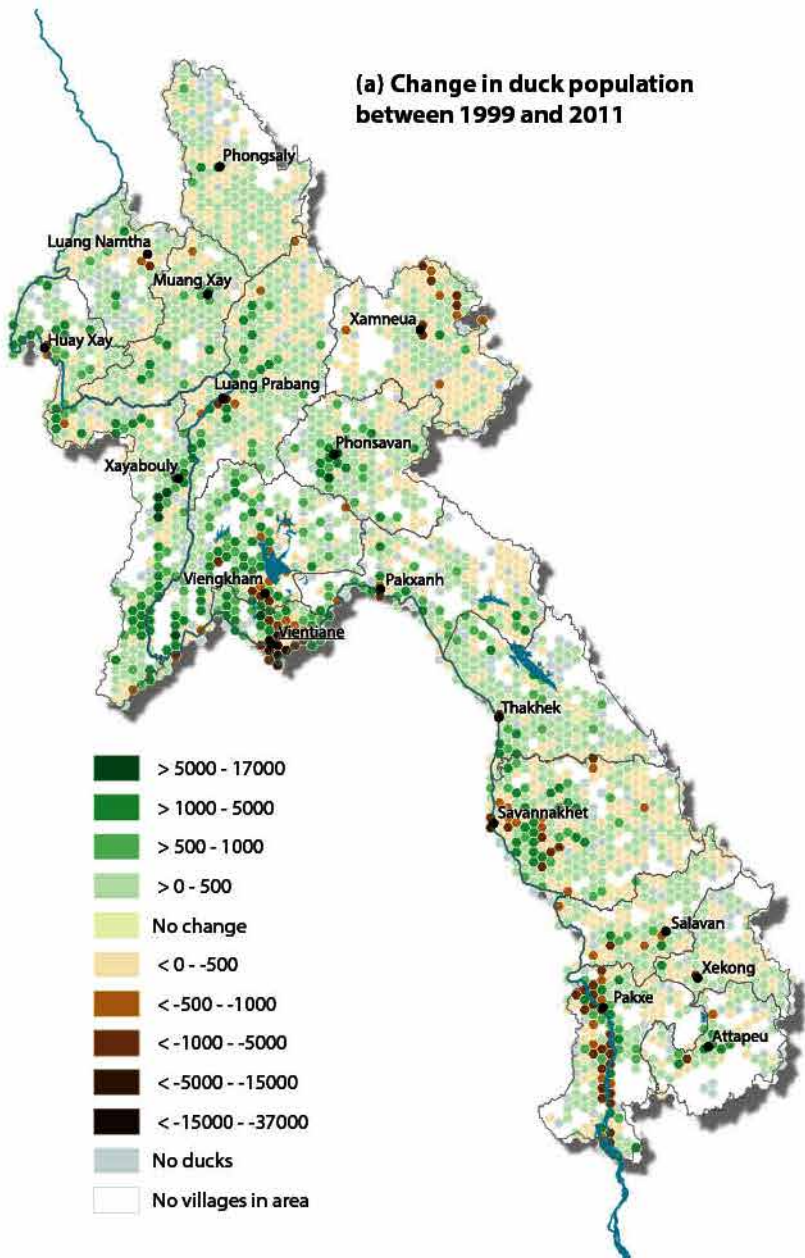
D7 Duck

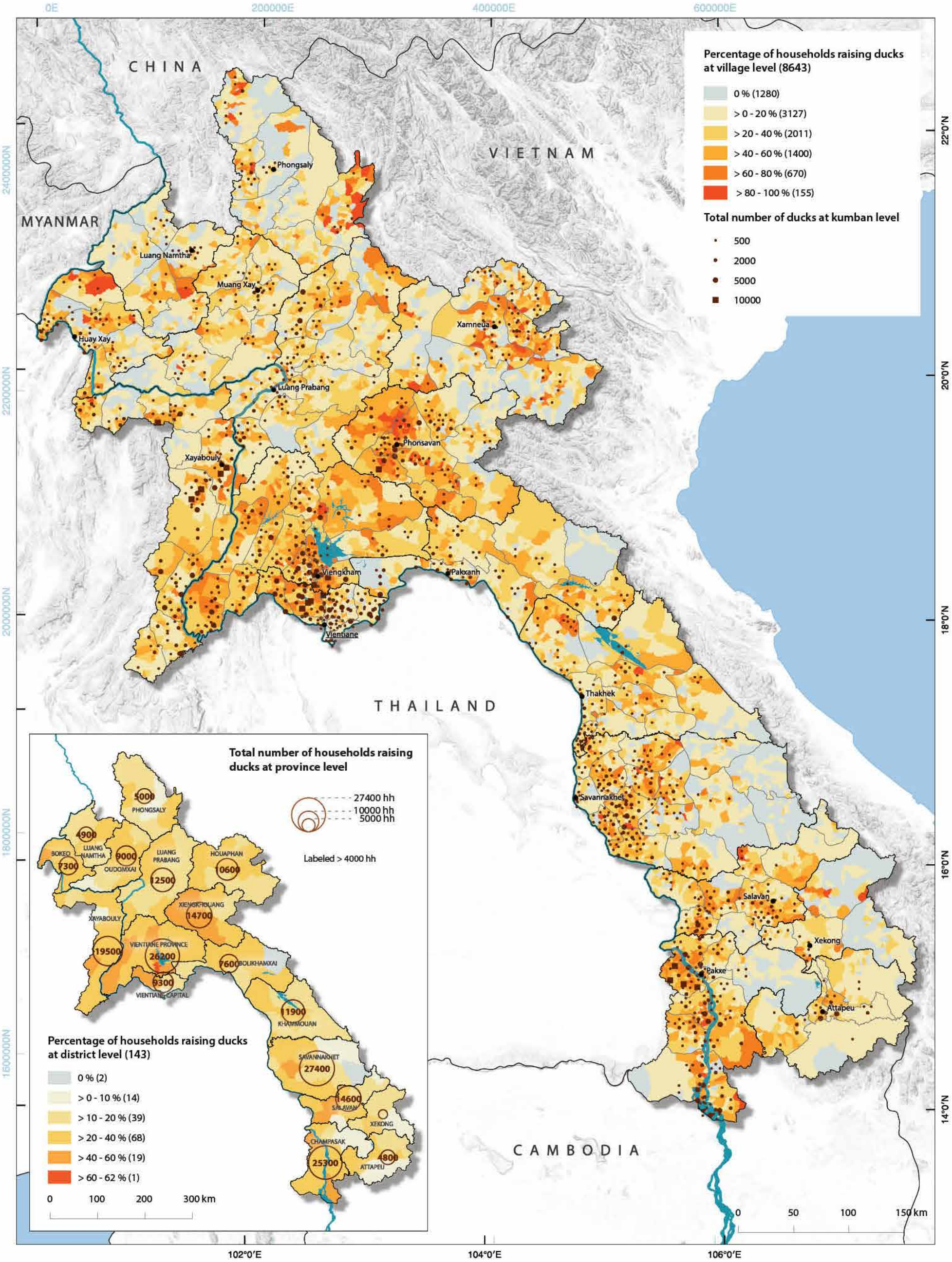
In the last two decades, Asian duck production has become increasingly important, accounting for 87 percent of the world’s duck population. In the Lao PDR, more than 90 percent of all households keep at least one species of poultry. Ducks are the second most common type of poultry raised in the Lao PDR, and the two main species of duck in the country are the Muscovy duck (*Cairina moschata*, or *pet kab* in Lao language) and the common duck (*Anas platyrhynchos*, or *pet theb*). In the Lao PDR, there are three main poultry production systems: traditional small-scale extensive backyard poultry production, accounting for about 84 percent of the national poultry flock; semi-intensive small- to medium-scale market-oriented commercial poultry production; and intensive large-scale industrially integrated poultry production (Burgos *et al.*, 2008). The traditional system is the most widely used in the Lao PDR, where most people raise ducks for household consumption.

In the Lao PDR there are 1,788,000 ducks owned by 212,700 households, which constitutes 27 percent of all agricultural households. The main map illustrates the percentage of households raising ducks at the village level. The hotspots for duck breeding are in Vientiane Province (261,200 ducks), Champasak (217,000 ducks), Xayabouly (204,000 ducks), and Savannakhet (184,000 ducks). Ducks are predominantly raised in the lowlands and also in plateau areas in the case of Phonsavan. The main map also shows that duck raising is more common and concentrated around province capitals.

Between 1999 and 2011, the duck population in the Lao PDR increased by 32.5 percent or by 318,300 heads in absolute terms. An increase was observed in almost all the provinces except for Vientiane Capital, Houaphan and Champasak. With an increase of 35 percent, Xayabouly Province experienced the largest increase in duck raising in the country. Vientiane Province and Xiengkhouang follow, with increases of 24 and 18 percent respectively. On the contrary, the provinces of Phongsaly, Luang Namtha, Salavan, Xekong and Attapeu experienced increases of less than 5 percent between 1999 and 2011.

As with other poultry, the outbreak of various diseases and limited knowledge and services for animal healthcare, nutrition, and management, have hindered the development of the duck raising industry in the Lao PDR. 13 highly pathogenic Avian Influenza outbreaks caused over 156,000 bird deaths in the country between 2004 and 2008. 8 of the 13 outbreaks occurred in February and March 2007, mostly in Vientiane Capital and predominantly in commercial farms, which lost as much as one-fifth of the national layer flock. The province-level inset map highlights this significant reduction in the duck population, which was mainly concentrated in Vientiane Capital.





D8 Fish capture

Inland capture fisheries in the Lao PDR are based mainly on water ecosystems consisting of rivers and river-basins, hydropower reservoirs, irrigation reservoirs and weirs, natural wetlands and floodplains, and wet season rice fields. The Department of Livestock and Fisheries reported in 2006 that the total area of water resources for fisheries is estimated to be about 1.2 million ha. The Lao population, especially in rural areas, relies heavily on aquatic resources such as fish and other aquatic animals, which are one of the most important sources of animal protein. In 2010, the Ministry of Planning and Investment reported that fish, frogs, turtles, snails and other aquatic animals provide more than 50 percent of the animal protein consumed by the population, which make them crucial to national food security.

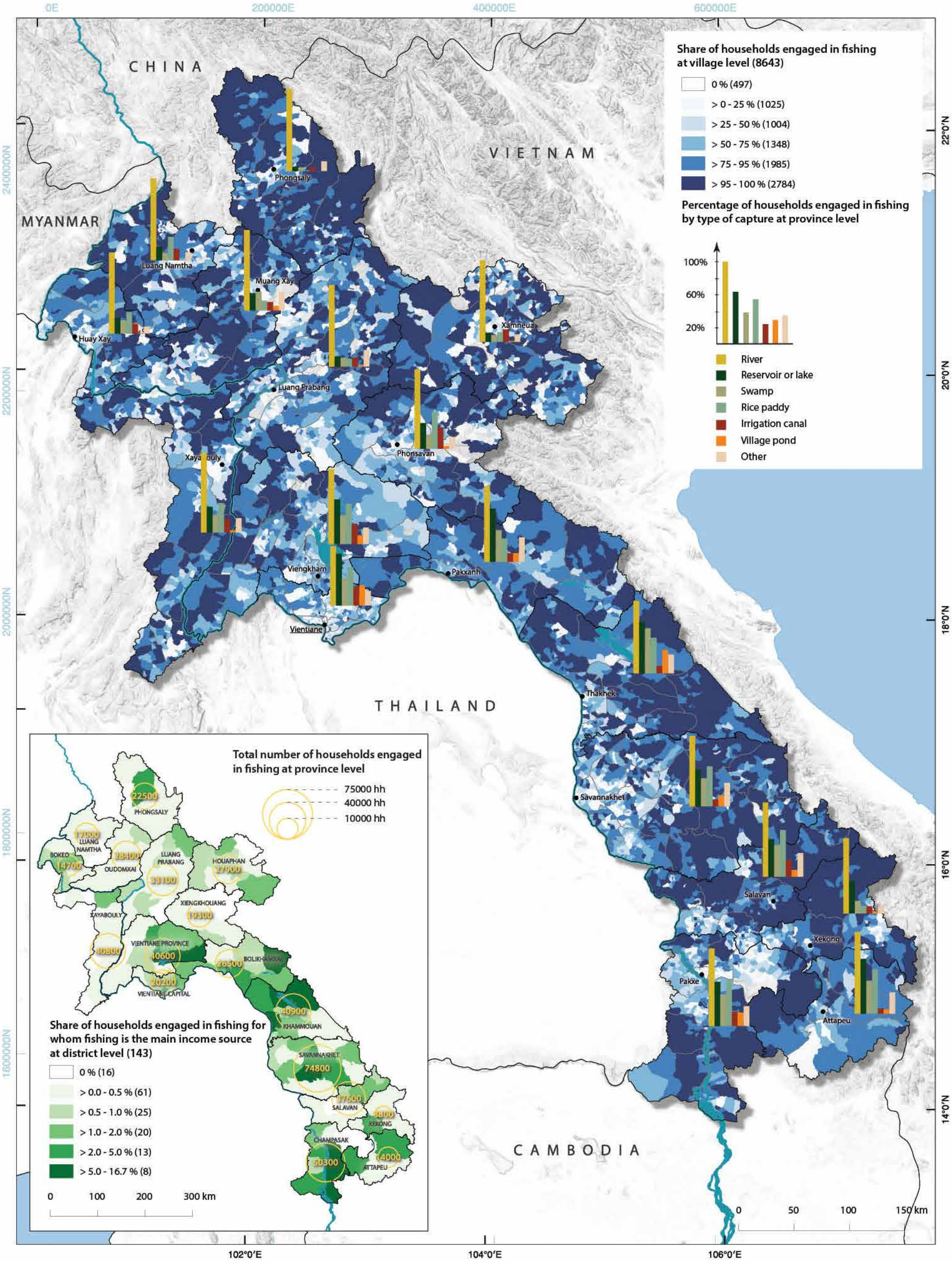
As the map illustrates, rivers are the main water ecosystem used for fishing across the country; indeed, 92 percent of agricultural households reportedly fish in rivers. Meanwhile, 40 percent fish in reservoirs or lakes, especially in central and southern Lao PDR. Given the large number of rice paddies in the country, it is not surprising that over one third (37 percent) of all households rely on rice fields for fish capturing. Similar to fishing in rice fields, fishing in swamps is practiced in all provinces, predominantly in south and central Lao PDR. On average, 29 percent of all households are engaged in catching fish from swamps.

In the Lao PDR, 526,300 households or about 67 percent of all agricultural households, engage in fish capturing. Savannakhet Province accounts for 15.2 percent (74,800 households) of all

households engaged in fishing. Champasak Province follows with 9.4 percent. The percentage of households engaged in fishing in Vientiane, Khammouan, Salavan and Xayabouly Provinces ranges between 7 and 8 percent. Luang Namtha, Bokeo, Xiengkhouang and Vientiane Capital altogether account for 13 percent of all fishing households in the Lao PDR. Due to its low population, Xekong is home to only 2.7 percent of all fishing households in the country. Although accounting for less than 8 percent of the country total, Khammouan Province has the highest percentage of households engaged in fishing (82 percent), and Bolikhamxai and Phongsaly follow with 79 percent each.

Fishing is the main income for very few agricultural households, since it is mostly done for household consumption rather than for sale. However, there are districts where between 5 and 16.7 percent of all agricultural households depend on fishing for their livelihoods. These districts are located in Vientiane Province (surrounding the Nam Ngum reservoir), Bolikhamxai (north of Nam Theun-Hinboun reservoir), Khammouan (surrounding Nam Theun 2), Savannakhet and Champasak (alongside the Mekong at the 4000 islands).

Between 1999 and 2011 the number of agricultural households involved in fish capturing increased by 61,600 (13.3 percent). The change was particularly marked in the northern provinces of Xayabouly, Oudomxai and Vientiane. An important decline in households engaging in fishing was found in the villages of Vientiane Capital, Luang Prabang and Pakxe, where overfishing, pollution and climate change contribute to this decrease.



D9 Aquaculture

The FAO defines aquaculture as “the farming of aquatic organisms, including fish, mollusks, crustaceans and aquatic plants”. Aquaculture in the Lao PDR is expanding, particularly small-scale operations. Around 68,200 agricultural households, or 9 percent of the total, practice some form of aquaculture. Aquaculture accounts for about 60 - 70 percent of all annual fish production in the country, and fish production is mainly done in ponds, rice paddies, or using tanks and cages. The most popular fish species bred in the Lao PDR are Chinese carp, bighead carp, grass carp, Indian carp, common carp, African catfish, snakehead and silver barb (DLF, 2005).

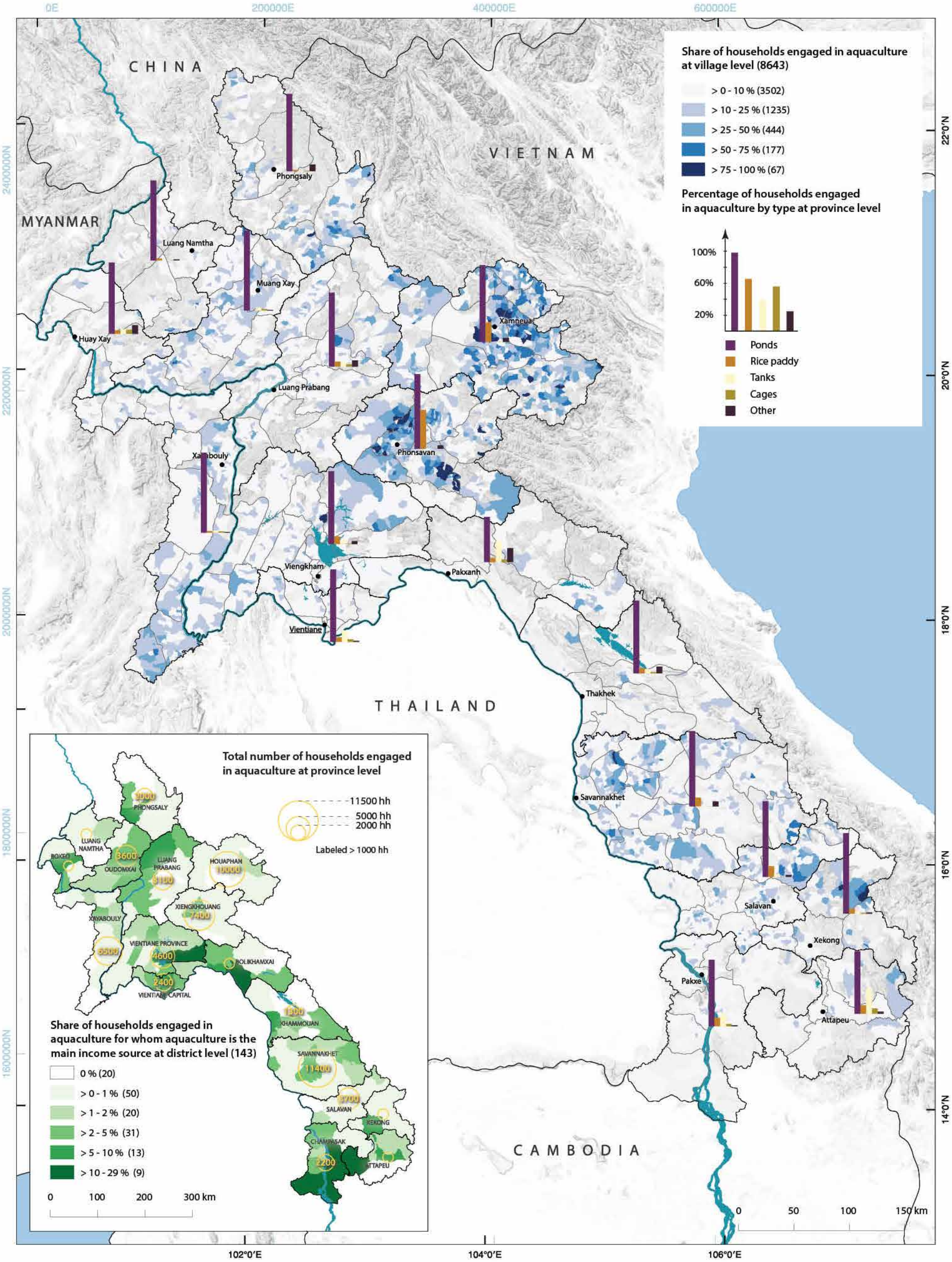
The number of households involved in aquaculture increased from 55,000 in 1999 to 62,500 in 2011. The highest percentages of households engaged in aquaculture are concentrated in central Lao PDR where 45 percent of all agricultural households are typically engaged in aquaculture, followed by the north with 42 percent and the south with only 13 percent of all agricultural households. On average, each household engaged in aquaculture uses 0.22 ha of land for their aquaculture production activities. Households in southern and central Lao PDR tend to devote larger areas of land to aquaculture than in the north.

In response to demographic growth, modifications in river hydrology, deforestation, and water pollution, agricultural households have developed various forms of aquaculture in order to secure their livelihoods and to earn income. In the Lao PDR, over 90 percent of all households engaged in aquaculture use ponds to produce fish, while 14 percent raise and capture fish in rice paddies. The main map demonstrates that Houaphan and Xiengkhouang Provinces have the

highest share of households engaged in aquaculture at village level. In these two provinces, one fourth and one-fifth of all agricultural households engage in aquaculture, most commonly using rice paddies for fish production. The most common fish species raised in rice paddy systems are *Cyprinus carpio*, *Carassius auratus* and *Oreochromis*. Cage fishing is employed by only one percent of all households engaged in aquaculture, and is practiced mainly in proximity to hydroelectric power reservoirs, along the Mekong River, and in irrigation reservoirs. Only 4 percent of households engaged in aquaculture use tanks for raising fish, mostly in Champasak and Bolikhamxai Provinces.

With 11,400 households engaged in aquaculture, Savannakhet has the highest number of aquaculture households in the country. Houaphan and Xayabouly follow with 10,000 and 6,500 households respectively. Despite being mainly oriented toward producing for household consumption, in 9 districts located in Champasak, Attapeu, Bolikhamxai and Vientiane Provinces, aquaculture is the main income source for at least 10 percent of households.

Aquaculture practices in the Lao PDR have changed and grown at a slow pace. Indeed, between 1999 and 2011, most provinces reported increases in the area used for aquaculture, as well as increases in aquaculture production levels, particularly in Xiengkhouang, Savannakhet, Salavan and Phongsaly Provinces. To keep up with these production levels, the government will need to invest substantially in controlling aquaculture production environments and addressing various risks arising from changing climatic conditions.



References and further reading

- ACO (2012) Lao Census of Agriculture 2010/11 – Highlights. Agricultural Census Office (ACO), Ministry of Agriculture and Forestry, Vientiane, Lao PDR.
- ADB (2005) Sector Assistance Program Evaluation for the Agriculture and Natural Resources Sector in the Lao People's Democratic Republic, Operations Evaluation Department Asian Development Bank, Manila, Philippines.
- ADB and WB (2012) Country Gender Assessment for Lao PDR. Reducing vulnerability and increasing opportunity, Mandaluyong City, Philippines and Washington DC, USA, Asian Development Bank and the International Bank for Reconstruction and Development/the World Bank.
- Agricultural Statistic Year Book (2015) Department of Planning and Cooperation, Ministry of Agriculture and Forestry, Vientiane, Lao PDR.
- Alton, C., Bluhm, D. and Sannanikone, S. (2005) Para Rubber in Northern Laos: the Case of Luang Namtha. Lao-German Program, Rural Development in Mountainous Areas of Northern Laos, Vientiane, Lao PDR.
- Aubertin, C. (2004) Cardamom (*Amomum spp.*) in Lao PDR: the hazardous future of an agroforest system product. In: Kusters, K. and Belcher, B. (eds.), Forest Products, Livelihoods and Conservation: Case studies of non-timber forest product systems. Volume 1- Asia, 43.
- Baird, I. (2011) Turning Land into Capital, Turning People into Labour: Primitive Accumulation and the Arrival of Large-Scale Economic Land Concessions in the Lao People's Democratic Republic, Journal of Marxism and Interdisciplinary Inquiry, Vol. 5 (1), University of Wisconsin-Madison, USA.
- Bouahom, B., Kingkeo, S., Phimpachanvongsod, V., Thao, L., Fahrney, K. and Aye, T.M. (2015) The changing role of cassava in rural poverty alleviation in Lao PDR, In: Howeler, R. (ed.), Sustainable cassava production in Asia for multiple uses and for multiple markets. International Center for Tropical Agriculture (CIAT), Cali, Colombia.
- Burgos, S., Otte, J. and Roland-Holst, D. (2008) Poultry, HPAI and Livelihoods in Lao Democratic Republic – A Review. Food and Agriculture Organization of the United Nation, http://cdn.aphca.org/dmdocuments/Study/WP05_081204.pdf, accessed 3 March 2016.
- Burnette, R. (2012) Three Cheers for Job's Tears: Asia's Other Indigenous Grain, A Regional Supplement to ECHO Development Notes Issue 13, <https://www.echocommunity.org/resources/d0eaf359-b4a4-43a1-801b-ab1320c1ba76>, accessed 20 November 2016.
- CFE-DM (2014) Center for Excellence in Disaster Management and Humanitarian Assistance - Disaster management reference handbook, <https://www.cfe-dmha.org/LinkClick.aspx?fileticket=IOMhs1ByC5U%3d&portalid=0>, accessed 1 November 2017.
- Chaisiricharoenkul, J., Tongta, S. and Intarapichet, K.-O. (2011) Structure and chemical and physicochemical properties of Job's tear (*Coix lacryma-jobi* L.) kernels and flours, https://www.researchgate.net/publication/267707183_structure_and_chemical_and_physicochemical_properties_of_job%27s_tear_coix_lacryma-jobi_l_kernels_and_flours, accessed 13 August 2016.
- Chiengthong, J. (2014) State, Capital, Border Traders, Farmers, and Cross-Border Corn, the 12th International Conference on Thai Studies, University of Sydney, Australia.
- Cooper, R. (2014) Laos – work in progress. Lao Insight books, Vientiane, Lao PDR.
- Cramb, R.A. and Newby, J.C. (2015) Trajectories of rice-farming households in mainland Southeast Asia, In: Cramb, R.A. (ed), Trajectories of rice-based farming systems, Australian centre for international agricultural research (ACIGAR), Canberra, Australia.
- DAFF (2012) Sugarcane. Department of Agriculture, Forestry and Fisheries, Pretoria, Republic of South Africa.
- Delgado, C., Rosegrant, M. and Wada, N. (2003) Meating and milking global demand: Stakes for small-scale farmers in developing countries, <https://ageconsearch.umn.edu/bitstream/124009/2/Delgado2003.pdf>, accessed 21 July 2016.
- Diane, R. and Alan, M. (2015) Sweet corn. Communications and Marketing, College of Agriculture and Life Sciences, Virginia Polytechnic Institute and State University, USA.
- DLF (2005) The National Strategy for Fisheries from the present to 2020: Action Plan for 2006 to 2010, Department of Livestock and Fisheries, Vientiane, Lao PDR.
- DLF (2015) The action Plan of Livestock and Fisheries for 2015-2020, Department of Livestock and Fisheries, Vientiane, Lao PDR.
- DOAC (2013) Status Paper on Sugarcane. Department of Agriculture & Cooperation, Ministry of Agriculture, New Delhi, India.
- Eliste, P. and Santos, N. (2012) Lao People's Democratic Republic Rice Policy Study, Food and Agriculture Organization (FAO), Rome, Italy.
- FAO (2010) FAO in Laos - Laos at a glance, <http://www.fao.org/laos/fao-in-laos/laos-at-a-glance/en/>, accessed 12 March 2016.
- FAO (2014) Lao Census of Agriculture 2010/11. Analysis of selected themes, Vientiane, Lao PDR, <http://www.fao.org/3/a-at767e.pdf>, accessed 17 March 2016.
- FAO (2016) Aquastat website. Food and Agriculture Organization of the United Nations, http://www.fao.org/nr/water/aquastat/countries_regions/LAO/, accessed 17 October 2016.

REFERENCES AND FURTHER READING

- FAOSTAT (2016) Peanut production in 2014, Food and Agricultural Organization of the United Nations, Statistics Division, <http://faostat3.fao.org/browse/Q/QC/E>. FAOSTAT, accessed 23 November 2016.
- FRC (2005) Summary of Rubber in Lao PDR. Forestry Research Centre (FRC). National Agriculture and Forestry Research Institute (NAFRI), Vientiane, Lao PDR.
- FRC (2016) Cardamom production and value chain in Laos. Forestry Research Center, NAFRI, Vientiane, Lao PDR.
- Fujita, Y. and Phanvilay, K. (2008) Land and forest allocation in Lao People's Democratic Republic: comparison of case studies from community-based natural resource management research. *Society and Natural Resources*, 21(2), 120-133.
- GIZ (2012) Microfinance in Lao PDR. GIZ, Vientiane, Lao PDR.
- Heiss, M.L. and Heiss, R.J. (2007) *The Story of Tea: A Cultural History and Drinking Guide*. Citing Modal, 519, Berkeley, USA.
- Hong, T. T. T., Linh, N.Q., Ogle, B. and Lindberg, J.E. (2006) Survey on the prevalence of diarrhea in pre-weaning piglets and on feeding systems as contributing risk factors in smallholdings in Central Vietnam. *Trop. Anim. Health Prod.* 38: 397-405.
- ICEM (2003) Lao PDR national report on protected areas and development, Review of Protected Areas and Development in the Lower Mekong River Region, International Centre for Environmental Management, Queensland, Australia.
- Inthapanya, P., Boualaphanh, C., Hatsadong, C. and Schiller, J. M. (2006) The history of lowland rice variety improvement in Laos. In: Schiller, J.M., Chanphengxay, M.B., Linquist, B.A. and Appa Rao, S. (eds.), *Rice in Laos*. International Rice Research Institute (IRRI), Los Baños, Philippines.
- IUCN and NERI (2011) Assessment of Economic, Social and Environmental Costs and Benefits of Mitr Lao Sugar Plantation and Factory: Case Study in Savannakhet Province. International Union for Conservation of Nature (IUCN) Lao PDR and the National Economic Research Institute (NERI), Ministry of Planning and Investment of Lao PDR.
- JICA (2011) Vientiane Capital - Urban development master plan - proposal, https://www.jica.go.jp/project/english/laos/009/materials/pdf/pamphlet_01.pdf, accessed 11 August 2016.
- Kaiser, C. and Ernst, M. (2010) Sweet corn. University of Kentucky College of Agriculture, Food and Environment, USA.
- Kenney-Lazar, M. (2013) Shifting Cultivation in Laos: Transitions in Policy and Perspective. Technical Report, Kyoto University, Japan.
- Larson, B. (2008) Entangled biological, cultural and linguistic origins of the war on invasive species. In: *Cognitive Linguistics Research: Frank, R.M., Dirven, R., Ziemke, T. and Bernardez, E. (eds.), Sociocultural Situatedness*, 169-195, Berlin, Germany.
- Leebouapao, L. and Voladeth, S. (2011) Agricultural Development, Trade, and Regional Cooperation in an Integrating and Industrializing East Asia. The Case of Lao PDR, In: Intal, Jr., P. S., Oum, S. and Simorangkir, M. J. O. (eds.), *Agricultural Development, Trade and Regional Cooperation in Developing East Asia*, 269-306, Jakarta, Indonesia.
- Lienhard, P., Chaivanna, S., Castella, J.-C., Phimmason, S., Phonekhampeng, C. and Khamxaykhay, C. (2015) Protecting riparian areas using Cardamom. *Eco-Friendly Intensification and Climate-resilient Agricultural Systems (EFICAS)*. DALaM, Vientiane, Lao PDR.
- Linquist, B.A., Keoboulapha, B., Sipaseuth and Inthapanya, P. (2006) Rice production systems of Laos. In: Schiller, J.M., Chanphengxay, M.B., Linquist, B.A. and Appa Rao, S. (eds.), *Rice in Laos*. International Rice Research Institute (IRRI), Los Baños, Philippines.
- LSUAFRP (2005) Promoting Soybean as a Cash Crop: Determinants and Possible Impacts. Lao-Swedish Upland Agriculture and Forestry Research Programme, NAFRI, MAF, Vientiane, Lao PDR.
- MAF (1999) Agriculture Statistic Yearbook 1999, Department of Planning and Cooperation, Ministry of Agriculture and Forestry, Vientiane, Lao PDR.
- MAF (2010) Strategy for agricultural development 2011 to 2020 draft Vientiane: Ministry of Agriculture and Forestry, Vientiane, Lao PDR.
- MAF (2012) Agricultural Statistics Year Book 2011, Ministry of Agriculture and Forestry (MAF), Vientiane, Lao PDR.
- MAF (2015) Agriculture and Forestry Development Strategy 2025 and Vision 2030. Ministry of Agriculture and Forestry (MAF), Vientiane, Lao PDR.
- MAF (2016) Strategy for Agricultural Development 5 years (2016-2020) Ministry of Agriculture and Forestry, Vientiane, Lao PDR.
- MAF/WREA (2010) Fourth national report to the Convention on Biological Diversity, Ministry of Agriculture and Forestry, Water Resources and Environment Administration, 101, Vientiane, Lao PDR, <http://www.cbd.int/doc/world/la/la-nr-04-en.pdf>, accessed 26 October 2013.
- Manivong, P., Mahavong, P., David, A., Homevongsa, V., Mongpadith, S. and Guitet, C. (2007) Participative analysis of coffee supply chain in Lao PDR. Groupe de Travail Café (GTC), Vientiane, Lao PDR.
- Manivong, V. and Cramb, R.A. (2008) Economics of Smallholder Rubber Expansion in Northern Laos: Agroforest System, Vientiane, Lao PDR, <https://doi.org/10.1007/s10457-008-9136-3>, accessed 11 March 2015.
- Manivong, V., Phouyyavong, K., Thongpadid, V., Phiasakha, V., Saycocie, S. and Bouahom, B. (2003) Field Report on Rubber and Sugarcane Markets in Northern Laos. Socio-Economics Research Component. Lao-Swedish Upland Agriculture and Forestry Research Programme. National Agriculture and Forestry Research Institute (NAFRI), Vientiane, Lao PDR.

- Marije, B. (2005) Peanuts Market Rapid Appraisal. Micro Projects Development through Local Communities. TABI, Vientiane, Lao PDR, <http://www.tabi.la/articlemapper/resources/NTFP%20Lao%20docs/Marketing%20of%20NTFPs%20in%20Laos/NTFP%20Marketing%20studies/Chompet%20Peanuts%20Marketassessment%20Feb05.pdf>, accessed 7 October 2017.
- Martens, S. D., Tiemann, T. T., Bindelle, J., Peters, M. and Lascano, C. E. (2013) Alternative plant protein sources for pigs and chickens in the tropics–nutritional value and constraints: a review. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, 113 (2), 101-123.
- Messerli, P., Epprecht, M. and Heinemann, A. (2009) Finding Homogeneity in Heterogeneity-A New Approach to Quantifying Landscape Mosaics Developed for the Lao PDR, Bern, Switzerland.
- Millar, J. and Phoutakhoun, V. (2008) Livestock development and poverty alleviation: revolution or evolution for upland livelihood in Lao PDR, *International Journal of Agriculture Sustainability*, 6, 89–102.
- MOPI (2010) The seventh national socio-economic development plan 2011-2015, Executive Summary, Ministry of Planning and Investment, Vientiane, Lao PDR, <http://www.rtm.org.la/documents/DRAFT%20NSED%20EX%20SUMMARY%20MAY%202010.pdf>, accessed 6 September 2015.
- MRC (2010) Social impact monitoring and vulnerability assessment report on a regional pilot study for the Mekong corridor, Mekong River Commission, MRC Technical Paper No. 30: 179, <http://www.mrcmekong.org/assets/Publications/technical/Tech-No30-Social-Impact-Monitoring.pdf>, accessed 15 November 2014.
- MRC (2012) The Impact & Management of Floods & Droughts in the Lower Mekong Basin & the Implications of Possible Climate Change, <http://www.mrcmekong.org/assets/Publications/basin-reports/FMMP-working-paper-110820.pdf>, accessed 3 April 2015.
- NAFRI (2011) Rubber Research in Lao PDR, National Agriculture and Forestry Research Institute (NAFRI), Vientiane, Lao PDR.
- NAFRI (2016) Sustainable Commercial Agricultural Production: A Case Study of Commercialized Banana Production in Lao PDR. National Agriculture and Forestry Research Institute (NAFRI), Vientiane, Lao PDR.
- Newby, J.C. (2016) Cassava farmers in Southeast Asia exposed to policy changes in global carbohydrate market. The official blog from the Australian Centre for International Agricultural Research (ACIAR), <http://aciarblog.blogspot.com/2016/04/cassava-farmers-in-southeast-asia.html>, accessed 17 March 2015.
- Pavelic, P., Clement, C., Somphasith, D., Snwoy-Haiblen, A., Karthikeyan and B., Keokhamphui, K. (2016) Enhancing the resilience and productivity of rainfed dominated systems in Lao PDR through sustainable groundwater use, https://www.researchgate.net/publication/315380626_Enhancing_the_resilience_and_productivity_of_rainfed_dominated_systems_in_Lao_PDR_through_sustainable_groundwater_use, accessed 1 November 2016.
- Pedersen, O., Carroll, M., Liang, C. and Shixiong, Y. (2016) Phou San Wild Tea in Xiengkhouang Province, Lao PDR. From Early Days to Current Production and Market Development. Agro-biodiversity Project, UNDP.
- Phengsavanh, P., Ogle, B., Stür, W., Frankow-Lindberg, B. and Lindberg, J.E. (2011) Small holder pig rearing system in Northern Lao PDR. *Asian-Australasian Journal of Animal Science*, 24, 867-874.
- Phommavong, T. (2010) Country Report – ASEAN training course on Aquaculture Production, MAF, NAFRI, Living aquatic resources research center, Vientiane, Lao PDR.
- Phouyyavong, K. and Talje, D. (2006) Case Study on Production and Market Conditions for Corn in Namor District, Oudomxay Province, Lao-Swedish Upland Agriculture and Forestry Research Program, NAFRI, Vientiane, Lao PDR.
- Poungchompu, S. (2015) Determinants of Technical Efficiency of Sugarcane Production among Small Holder Farmers in Lao PDR. *American Journal of Applied Sciences* 2015, 12 (9), 644-649.
- Qiu, L. J. and Chang, R. Z. (2010) The origin and history of soybean. In: Singh, G. (ed.) *the soybean: botany, production and uses*. CABI Publishing, Oxford, UK.
- Rouw, A.D., Baranger, P. and Souliad, B. (2002) Upland Rice and Job's Tear Cultivation in Slash and Burn Systems under very Short Fallow Periods in Luang Prabang Province. *The Lao Journal of Agriculture and Forestry*, NAFRI, Vientiane, Lao PDR.
- Schiller, J.M., Hatsadong and Doungsila, K. (2006) A history of rice in Laos. In: Schiller, J.M., Chanphengxay, M.B., Linquist, B.A. and Appa Rao, S. (eds.) *Rice in Laos*. International Rice Research Institute (IRRI), Los Baños, Philippines.
- Schiller, J.M., Manivong, V. and Phengvichith, V. (2013) Lao PDR – Rice Production and Food Security. *The Lao Journal of Agriculture and Forestry*, No. 28, January-June 2013, 116-135, NAFRI, Vientiane, Lao PDR.
- Setboonsarng, S., Leung, P.S. and Stefan, A. (2008) Rice contract farming in Lao PDR: Moving from subsistence to commercial agriculture. ADBI Discussion Paper 90, Tokyo, Japan.
- Shurtleff, W. and Aoyagi, A. (2004) History of fermented soymilk and its products. History of soybeans and soy foods, 1100 B.C. to the 1980s, Soyinfo Center, Lafayette, USA.
- Singh, A.K. and Nigam, S.N. (1997) Groundnut, In: Fuccillo, D., Sears, L. and Stapleton, P. (eds.) *Biodiversity in Trust*. Cambridge University Press, UK, <https://www.cambridge.org/core/books/biodiversity-in-trust/groundnut/F14F5A5AA58616B928C20D1F6560CCBB>, accessed 1 July 2017.

- Somlith, V. (2017) Agriculture Section, Champasak Provincial Agriculture and Forestry Office, Vientiane, Lao PDR.
- Sourideth, V., Ouanesamone, P. and Newby, J.C. (2011) Factors influencing the adoption of corn in irrigated rice-based farming systems in Lao PDR. International Conference on Conservation Agriculture, Brisbane, Australia.
- Stür, W., Gray, D. and Bastin, G. (2002) Review of the livestock sector in the Lao People's Democratic Republic. International Livestock Research Institute, Manila, Philippines.
- Thongmanivong, S. and Fujita, Y. (2006) Recent Land Use and Livelihood Transitions in Northern Laos. Mountain Research and Development, 26 (3), 237-244, Bern, Switzerland.
- UN in Lao PDR (2017) SDG 5: Gender, Achieve gender equality and empower all women and girls, <http://www.la.one.un.org/sdgs/sdg-5-gender>, accessed 11 October 2017.
- UNDP (2010) Developing a national risk profile of Lao PDR, http://www.adpc.net/igo/category/ID275/doc/2013-sWNa61-ADPC-Final_Report_Part1.pdf, accessed 7 March 2016.
- UNDP (2016) Cardamom Agronomy, Marketing & Extension-Services Study & Capacity Building. Northern Uplands Development Programme, MAF, Vientiane, Lao PDR.
- UN-Habitat (2004) Pakse, Lao People's Democratic Republic - Climate Change Vulnerability Assessment. United Nations Human Settlements Programme.
- UXO Lao (2013) Lao national unexploded ordnance programme, UXO impact, <https://www.uxolao.org/index.php/en/the-uxo-problem/uxo-impact>, accessed 14 August 2014.
- UXO-NRA (2014) National regulatory authority for UXO/mine action sector in Lao PDR, <http://www.nra.gov.la/uxoimpact.html>, accessed 3 February 2015.
- Van Kerkhove, M.D., Mumford, E., Mounts, A.W., Bresee, J. and Ly, S. (2011) Highly pathogenic avian influenza (H5N1): Pathways of exposure at the animal-human interface, a systematic review. PLoS ONE, e14582.doi:10.1371/journal.pone.0014582.
- Wilson, R. (2007) Status and prospects for livestock production in the Lao People's Democratic Republic. Tropical Animal Health Production, Vol. 39 (6), 443-452.
- World Bank (2008) Lao People's Democratic Republic: Policy, Market, and Agriculture Transition in the Northern Uplands, Washington DC, USA.
- World Education (2016) Value chain assessment report - Lao Ngam. Assessment of Value Chains to Support Sustainable Livelihoods for the Poor through Inclusive Economic Development Lao Ngam District, Salavane Province, <http://53c5r2vuv7y1h7ipr2fx8kut.wpengine.netdna-cdn.com/wp-content/uploads/2014/10/World-Education-Value-Chain-Assessment-Lao-Ngam-2016.pdf>, accessed 1 February 2014.
- Wu, Y., Chanhda, H., Xiaoling, Z., Yoshida, A. and Cifang, W. (2011) Tea industry development and land utilization along the China-Laos border: A case study of Komen Village in Laos. African Journal of Business Management, Vol. 5 (11), 4328-4336.

Atlas of Agriculture in the Lao PDR

Patterns and trends between
1999 and **2011**

The agricultural landscape of the Lao PDR is experiencing important changes. During the first decade of the twenty-first century, the share of agriculture's contribution to the national economy declined, while the agricultural population grew, the area used by households for agricultural increased significantly, and agricultural production systems became more commercialized and increasingly productive. These trends, however, are far from uniform across the country, and great differences in agricultural production patterns and their dynamics exist between the different regions.

This first Atlas of Agriculture in the Lao PDR draws on the rich statistical database of the agricultural censuses of 1999 and 2011, and presents highly detailed maps of the manifold aspects of Lao household's agricultural production, and reveals the changes they have undergone during the first decade of the century.

The depth of new insights into dynamics in the agricultural sector presented in this atlas is expected to aid rural development analysis, planning, and respective decision-making among a wide range of public and private users.

The atlas was developed jointly by the Ministry of Agriculture and Forestry MAF of the Government of the Lao PDR, and the by Centre for Development and Environment CDE of the University of Bern, Switzerland, within the framework of the Lao DECIDE info initiative. The initiative is funded by the Government of Switzerland through the Swiss Agency for Development and Cooperation (SDC), and aims at promoting information sharing and integration towards enhanced development analysis and planning.



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

**Swiss Agency for Development
and Cooperation SDC**

u^b

**UNIVERSITÄT
BERN**

CDE
CENTRE FOR DEVELOPMENT
AND ENVIRONMENT